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THE

AQUARIAN NATURALIST.

A MANUAL FOR THE SEA-SIDE.

38898

BY

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TO

THE MEMBERS

OF

THE LONDON INSTITUTION

THIS WORK

IS RESPECTFULLY DEDICATED

PREFACE.

Our lamented friend the late Hugh Miller, in his delightful work "The Cruise of the Betsy," surmises that some parties might have thought the geological chapters of the volume more entertaining if all the geology had been left out; and yet, even with such an authority before us, we flatter ourselves that, in a work written professedly on the subject of the Marine Aquarium, a sketch of the Natural History of its inmates will be considered at least not misplaced.

In the following pages we have collected the principal facts connected with the ascertained habits and œconomy of various races of animals inhabiting our own shores, with a view of directing the attention of the amateur naturalist to subjects most likely to afford materials for useful and instructive observation, and likewise in the

hope of supplying the student of Nature with a manual sufficiently comprehensive to serve as the basis and foundation of more elaborate research. In the treatment of our subject, we have sought, as far as possible, to steer a middle course between the two extremes of mere elementary shallowness on the one hand, and scientific technicality on the other; omitting, it is hoped, little that will be deemed of importance by the general reader, and at the same time studiously avoiding such details as might be unintelligible, except to the initiated. We have endeavoured, in short, to comply as far as possible with the requisition of our lady-friends,—to write as much as possible about what they do want to know, and as little as possible about what they do not want to know. How far we have succeeded in our task, we leave to their merciful consideration.

Athenæum Club,
June 1858.

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THE

AQUARIAN NATURALIST.

MARINE ANIMALS.

CHAPTER I.

Fond man! yon glassy mirror eye—
Go, pierce the flood, and there descry
The miracles that float between
The rainy leaves of watery green;
Old Ocean's hoary treasures scan;
See nations swimming round a span.—CRABBE.

INTRODUCTORY.

WHO among us but remembers with pleasurable emotion those happy days, when, with a boyish rod and line, we caught our first minnows in the way-side brook, and the delight with which we landed on the grass our tiny victims—the deep regret with which we saw them die, and all their splendid colours fade? Who forgets, when, with an effort to preserve the pretty dwellers in the stream, he next appeared, bottle in hand filled with clear water, and essayed to take them home alive and see them swim in their imprisonment, gazing with rapture on their silvery hues and

active movements,—hoping all the time—vain hope! —to keep them as his own? An hour or two, and they were floating on their backs, gasping their little lives away in helpless agony!

Or in maturer years, when visiting the shores of the wide Sea in search of health or for amusement, who amongst us has not yearned to keep alive and make his own the countless lovely objects that surround his path; and, as they woo his admiration, seem to court his care in order to preserve their fading beauties? How often has he tried, in vessels filled with their native element, to rear them; but has seen them die in spite of all his efforts, melt away before his eyes, and,

> "....like the baseless fabric of a vision,
> Leave not a wreck behind!"

Should he ask himself why he thus fails, the simple answer is, he did not change the water, and they died.

It is a lovely morning; let us stroll awhile upon the shingly beach and watch the ebbing tide. How stealthily the sea retires!—each gently curtseying wave, as its last ripplings sink upon the sand, leaving a line of foam to show how far it had presumed to come. The rocks are now laid bare, over whose weed-crowned heads the gentle spray is tossed in feathery wreaths, which, sparkling in the sunbeams, shine with all the rainbow's hues; until the sinking waters leave the limpet-covered crags in silent loneliness. We climb their slippery sides, and sit us down beside some rock-girt pool, whose tranquil surface, stirless as a glass, permits us to survey the depths below, clear and translucent. Sea-weeds of roseate hues and forms

more delicate than those of earth, in rich profusion clothe the sides and bottom; others of varied dyes, purple and green, hang loosely floating in the quiet depths; pensile Confervæ wave from every stone—a wilderness of vegetation. Interspersed with these, the jointed Corallines spread forth their stony branches, and Sea-flowers of every colour, opening to the sun, unfold their living petals to entrap their food. The glassy shrimps and prawns are faintly seen, lost in their own transparency; and little fishes darting here and there, or poised with quivering fins, give life and animation to the scene.

The sun becomes obscured, and the breeze freshens from the sea; dark clouds are gathering on the horizon, and the tide begins to turn; the heaving waves now tumble towards the shore, and as they break, in angry foam, portend a storm. The sky looks threatening, and the thunder growls far in the distance. The sea awakens as from slumber, and the blackening heavens lour over its dark bosom; while the rising blast, impelling all the waves, drives them upon the rocks in sheets of feathery foam, lashing them on to madness, till at length ocean and sky seem mingled. The raging winds now

> "....take the ruffian billows by the tops,
> Curling their monstrous heads, and hanging them
> With deafening clamours in the slippery clouds;"

from whence they fall into the yeasty depths, where all is violence and roar and rage.

Such are the changing aspects of the Sea, and such the efficient means whereby Nature ensures the renovation of that element, the mighty deep, the grand

antagonist of all the earth—refreshing it throughout its broad domains, keeping its waters wholesome—filled with air, and thus adapted to afford the means of respiration to the living things that flourish in its vast recesses. It is evident, that it is only by imitating the conditions observable in Creation that we can ever hope to succeed in our attempts at keeping alive and in health for any lengthened period animals that we desire to preserve in our Vivaria, and it is not difficult for the observant mind to perceive how those conditions are to be fulfilled. Water itself, while in a stagnant state, affords no air such as can be respired by any animal. To fill it then with atmospheric air, or *oxygen*, the purer element, must be the first essential; secondly, to keep it stored with food adapted to the nourishment of those creatures that we place in it, is as imperatively requisite. The storms that tempest ocean, "making the sea to boil like a pot," effect the former condition by commingling the air of the atmosphere with the waters of the sea. The vegetation which clothes the rocks and carpets the shallows, or floats through every region, when exposed to sunshine, as we all well know, pours forth oxygen gas in abundance sufficient to replace that which is consumed by respiration, and moreover yields such ample stores of food as will supply all the vast hunger of the mighty deep. With these two grand facts before us, it is manifest upon what principles an Aquarium ought to be established; how those principles may be put in practice must be the next object of our inquiry.

It is easy to enunciate a broad fact; but the application of it is a very different thing. Mankind knew

long ago the expansive force of steam; but it required the united genius of many mighty minds to realize the steam-engine. The facts above narrated have been long enough sufficiently well known; but we are indebted to the patient inquiries of Mr. Warington and Mr. Gosse for those practical instructions, which introduced into our drawing-rooms the most elegant productions of the ocean, and enabled the student of Creation, at his own fireside, to carry out observations of deep importance, both to the Natural Historian and the Physiologist, which heretofore were scarcely possible even on the seashore. It is to these gentlemen, therefore, we must principally have recourse for information as to the manner in which our Aquaria should be constructed and prepared.

The form of aquarium which, after some years' experience and observation on the various animated tenants of these miniature seas, Mr. Warington has now adopted, consists of a four-sided vessel, having the back gradually sloping upwards from the bottom, at an angle of 45 to 50 degrees, and the consequently extended top sloping slightly downwards, and resting on the upper part of the back. The bottom therefore becomes necessarily narrow. The front, for the purposes of observation, and the top, for the admission of light, are of glass; the back, ends and bottom being constructed of slate, the whole fixed in a stout framework.

The advantages of this arrangement are,—

First, that it allows of a most extended view of the whole interior of the aquarium.

Secondly, that it enables the occupants to resort to

any depth they may desire, or even to ascend the sloping back and emerge from the water.

Thirdly, it admits of a much larger surface being exposed to the action of light; and,

Fourthly, the sloping top allows the water which condenses on the glass to trickle off and return to the aquarium, without first resting on the zinc or iron framework. It need hardly be suggested, that the sloping back is to be covered with light rock-work extending to a short distance above the water-line.

Let it not, however, be supposed, that although the form of tank above described by Mr. Warington may be the best in its general construction, it is by any means indispensable; tanks of all shapes and sizes are now to be readily procured at moderate prices adapted to all tastes. Yet even these are luxuries: a common show-glass, such as we see in confectioners' shops, a large glass gold-fish globe, or, in default of these, a common earthenware pan will be found to answer every end—as far, at least, as relates to the preservation of specimens for the purposes of scientific research.

The common propagating glasses used by gardeners, and which may be procured of almost any size, form admirable substitutes for the more expensive plate-glass tank; and the broad shallow glass pans now generally in use for holding milk, will be found in many cases even more convenient than deeper vessels. They say that it is only the bad workman who finds fault with his tools, and upon the same principle the real naturalist will never be at a loss for an appropriate vessel as long as a dish or a basin can be obtained.

Half-a-dozen finger-glasses, such as are generally placed upon the table after dinner, will be found invaluable, and for containing small specimens, adapted to microscopical examination, even preferable to vessels of larger size. Let one of these be filled three-parts full of fresh and pure sea-water—strew the bottom with a few small stones and bits of rock, on which are growing Confervæ and young Sea-weeds in a state of vigorous growth, and you at once have an aquarium fitted for the reception of an infinite variety of interesting objects. Hydræ and Corynæ, Sertularian and Tubularian Zoophytes, Crisiæ, Bowerbankiæ, and the whole host of Polyzoa, the delicate Tubularia, and the many-polyped Anthozoa, here grow luxuriantly, and may be kept for months under examination.

In the arrangement of a large tank, one of the most important features to be attended to is the introduction, upon a miniature scale, of rock-work, whereby the surface for the growth of plants may be most materially increased, and a picturesque appearance given to the aquarium, which could not possibly be attained without such an expedient. A wide field is here opened for the display of taste and ingenuity; it is a piece of landscape gardening upon a small scale, on which every amateur may exercise his talents with advantage, always keeping in view the various uses to which the miniature rockery ought to be subservient. The first of these, as we have already said, is to increase the superficial extent of the interior of the aquarium, and present a larger surface for the growth of vegetation, a circumstance of primary importance in the arrangement; for, as we shall shortly perceive, the

entire superficies of these rocks speedily becomes invested with a dense vegetable growth, itself sufficient to aërate and keep in a healthy condition the entire contents of the aquarium, even without the introduction of plants of more conspicuous character; every stone in time becomes covered with a thick and moss-like carpet, from whence, in the sunshine, bubbles of oxygen may be seen to stream in copious abundance, and almost rendering other care unnecessary. A second important use derivable from the rock-scenery we are here recommending, is the provision of shelter and secure retreat for such animals as may require an asylum. We ought always to bear in mind, that the more nearly we can imitate the usual habitat of our *protégées*, the more successful will be our efforts to preserve them in a healthy condition. A little reflection will at once teach us, that to seek retirement and seclusion, except at certain times of the day, is with many animals an imperative instinct, a law of their economy that cannot be broken without producing injurious effects. It is therefore desirable so to dispose our materials as to leave caves and crannies and hiding-places, whereunto animals requiring such protection may betake themselves.

Shade likewise is a desideratum of no trifling importance: constant or even prolonged exposure to the full glare of daylight must necessarily prove prejudicial to animals that frequent the umbrageous pools, or delight in the seclusion of dimly-illuminated corners of their native localities. In the construction of our rock-work, therefore, this point should by no means be lost sight of.

It is always best to build up the rock-work with loose stones, placed upon the bottom of the tank—arranging them in such a manner, that not only shelter, shade, &c., may be afforded to the contained animals, but that they may be enabled to station themselves at any depth in the water which their habits or choice may lead them to select.

The best materials for this purpose will be found to be pieces of granite or of limestone of various shapes and sizes; but all of such weight and regularity of form, that, when placed one upon the other, in accordance with the taste or intention of the designer, they may rest firmly and securely in their respective places. No cement should be employed in the construction of these mimic edifices; their weight alone and steady supraposition upon each other should ensure the firmness and stability of the entire fabric.

Rude bridges of Cyclopian masonry—edifices somewhat after the pattern of Stonehenge and other Celtic piles—caverns of wave-worn rock and craggy terraces—should rise above each other, till the top, reaching above the level of the water, forms a little island of dry land.

We will, however, now confine our attention to the permanent Aquarium, and the mode of its establishment. We suppose the rock-work to have been arranged in accordance with the shape and dimensions of the tank, and scars and reefs, and cliffs and caves, to be adequately represented without needlessly occupying the valuable space in the interior.

The next step, of course, is to lay down the bottom of our miniature sea, so as to adapt it to the comfort

and well-being of its intended inhabitants. Here (and the arrangement is of considerable importance) we must study Nature. The floor should be composed of smooth washed shingle, the stones resembling in size a pea, a bean, up to a hazel-nut, as a substratum; but with, here and there, a larger piece, whose bulk, like Skiddaw or Helvellyn, so to compare great things with small, may protrude through the alluvial plain to be deposited above. Upon the top of this, a stratum of fine sand (sea-sand) should be spread to the depth of at least three-quarters of an inch or more.

The uses of this sea-sand are, in some measure, as we shall find hereafter, important in relation to many species of marine animals that hide themselves under its shelter, or derive from it the materials wherewith to build their habitations; but at present we must regard it in its Hygeian character, in so far as it is important to the maintenance of the health of the entire community.

Whoever upon the sea-shore takes the trouble to dig to the depth of a few inches, more or less, according to the peculiar circumstances of the locality, will find beneath the clean and wholesome sand a layer of black, or bluish, paint-like, stinking slime, the dregs and filth deposited, as it were, by filtration. Any one who has stood upon the beach where the receding tide, by washing away the surface-sand, and laying bare this foul accumulation, has thus stirred up the abominable odours of the Stygian pool, can vouch for the deleterious effluvia that emanate from this pestiferous deposit, which, were it not thus safely buried, would poison the entire coast, and

render the shores uninhabitable. The naturalist ought therefore to be very cautious how he allows the bottom of an old-established tank to be disturbed; still more so in permitting the casual introduction of any shell or stone into his aquarium that is polluted with this noisome pestilence. We have ourselves lost many valuable colonies owing to the imprudent zeal of friends, who, in their anxiety to add some new-found specimen to our stock, have neglected thoroughly to cleanse the shell, or pebble upon which it was attached, from the adherent filth.

To procure a supply of sea-water adapted to the purposes of the Aquarium is the next consideration; and simple as this part of the business may appear, it is by no means always an easy matter even to parties resident upon the sea-shore. On certain favoured beaches, it is true, nothing more is requisite than to take a watering-can to the water's edge, and fill it from the brimming ocean; but this is unfortunately rather an exceptional privilege. On most of our coasts, too, it generally happens, that during both the advancing and receding tide, the muddy shore, stirred up by the incessant turmoil of the waves, pollutes the sea to such an extent that it is quite inadmissible into the tank. So that the naturalist, like the poor thirst-parched mariner, with

> "Water, water, all around,
> And not a drop to drink!"

eyes the expanse of dirty waves in a state of hopeless tantalization. In such a case, the only chance is to procure a boat, and obtain, at a sufficient

distance from the shore, a cargo from the clear green billow.

The element wherein the captives are kept should be always sweet and quite clear; the vessels clean, and free from tainted matter. Some specimens fall immediate victims to putrescence; others can resist it wonderfully, either endeavouring to escape by ascent or by descent, according to their peculiar nature, or closing themselves up, as if to avoid its deadly influence. The water for most of the Crustacea should be free from mud, and contain eminences whereon they may rest, at will, above the surface. But muddy solutions are essential to most of the bivalve Testacea, and to all the Ascidian tribes; a certain proportion of mud is likewise grateful to several Amphitrites, and to many Annelidans, as sand is to the various species of *Nereis*.

An excellent test whereby to judge of the purity and wholesome condition of the water may be established by the simple introduction of a few living specimens of the Acorn-shell or Barnacle (*Lepas*), which are to be found abundantly, adherent to stones or shells, on any part of the coast. Whilst these continue active and healthy, as testified by the energetic display and contraction of their delicate and highly sensitive arms, we may rest quite satisfied that all is going on well; but, on the other hand, their inactivity ought to call attention to the condition of the tank.

The inconvenience, delay and expense attendant upon the procuring of sea-water from the coast, or from the ocean, Mr. Gosse soon felt to be a great

difficulty in the way of a general adoption of the Marine aquarium. Even in London it is an awkward and precarious matter; how much more in inland towns and country places, where it must always prove, not only a hindrance, but, to the many, an insuperable objection! The thought, therefore, naturally presented itself to that gentleman, that, as the constituents of sea-water were known, it might be practicable to manufacture it; since all that seemed necessary was to bring together the salts in the right proportion, and add pure water till the solution was of the proper specific gravity.

Taking Schweitzer's analysis of the sea-water obtained off Brighton as his guide, and thinking that a few unimportant ingredients found in very inconsiderable quantity might be safely omitted, the essential component salts were reduced to four, which Mr. Gosse employed in the following quantities:—

Common table-salt . . .	3½	ounces.
Epsom salts	¼	ounce.
Chloride of magnesium . .	200	grains Troy.
Chloride of potassium . .	40	„ „

To these salts, thrown into a jar, a little less than four quarts of water (New River) were added, so that the solution was of such density that a specific-gravity bubble 1026 would just sink in it.

The cost of these materials is:—Epsom salts, 1*d.*; chloride of magnesium, 3*d.*; chloride of potassium, 1¼*d.*; salt, nil. Total, 5¼*d.* per gallon. The trouble is nothing, and no professional skill is required.

"My manufacture," says Mr. Gosse, "was made

on the 21st of April. The following day I poured off about half of the quantity made (filtering it through a sponge in a glass-funnel) into a confectioner's show-glass. I then put in a bottom of small shore pebbles, well-washed in fresh water, and one or two fragments of stone with fronds of green sea-weed (*Ulva latissima*) growing thereon. I would not at once venture upon the admission of animals, as I wished the water to be first somewhat impregnated with the scattered spores of the Ulva, and I thought that if any subtle elements were thrown off from growing vegetables, the water should have the advantage of it before the introduction of animal life. This, too, is the order of Nature —plants first, then animals.

"A coating of green spores was soon deposited on the sides of the glass, and bubbles of oxygen were copiously thrown off every day, under the excitement of the sun's light. After a week, specimens were introduced into the vivarium thus prepared for their reception. These grew and flourished from day to day, manifesting the highest health and vigour: the plants, including one or two red sea-weeds that were put in with the animals, looked well, and the water continued brilliantly crystalline. In short, the experiment succeeded perfectly, and we may now employ with confidence the artificial element when real sea-water cannot readily be procured."

The proportions of saline materials recommended by Mr. Warington for the formation of artificial sea-water are somewhat different from those employed by Mr. Gosse, and correspond more accurately with Dr. Schweitzer's analysis.

They are as follow:—

Chloride of sodium	$43\frac{1}{4}$ ounces.
Chloride of magnesium . . .	6 „
Chloride of potassium	$1\frac{1}{4}$ „
Bromide of magnesium . . .	21 grains.
Sulphate of magnesia . . .	$7\frac{1}{2}$ ounces.
Sulphate of lime	$2\frac{5}{4}$ „
Carbonate of lime	21 grains.
Water	9 gallons and 5 pints.

There cannot be a question, however, that by far the simplest plan would be to evaporate sea-water itself in large quantities, preserving the resulting salt in closely stopped vessels, to prevent the absorption of moisture, the proportion of this dry saline matter being $56\frac{1}{2}$ ounces to the ten gallons of water less three pints*.

Another important point is the specific gravity of the sea-water†. This should be very carefully regulated; for it must be borne in mind, that many of the marine creatures are supplied with materials for their support by a permeation of water through their tissues, or over their different organs. The specific gravity should not rise above 1026 at 60° Fahr., and a small hydrometer should be at short periods introduced to

* Such a preparation is in reality manufactured by Messrs. Brewl and Schweitzer of 71 East Street, Brighton, under the title of "Marine Salts for the instantaneous production of Sea-water," and may be purchased in London from Mr. William Bolton, Operative and Manufacturing Chemist, 146 Holborn Bars.

The proportion ordered to be used is six ounces to the gallon of water; to be stirred well until dissolved.

† Warington, Ann. Nat. Hist. 1853.

ascertain that this point is not exceeded, especially during the hot months of summer. The reduction of this gravity can be readily effected by the addition of rain- or distilled water. Many of the creatures will of themselves afford indications of this increase of density. Some of the Actiniæ will remain closed, and become coated with a white slimy covering, within which they remain for a length of time; when, if the specific gravity be lowered, this is very soon ruptured by their expansion, and thrown off by the movements of the tentacula.

The importance of the foregoing remarks will be at once appreciated, when we remember, that while the water of the marine aquarium is undergoing a continual diminution by evaporation, the salt does not evaporate; so that the solution of salt, becoming progressively stronger and stronger, would be at last converted into brine so strong, that no animals could exist in such a *pickle*. A "specific-gravity bubble," exactly adjusted for the purpose, and which may now be purchased from any dealer in Aquaria, left to float in the tank, will indicate, by rising to the top, when dilution is requisite, and its faithful monitions should be at once attended to.

Our tank being thus prepared and filled with pure sea-water, or its equivalent, the artificial solution of marine salts, we next proceed to place in it appropriate vegetation, as a necessary preliminary to the introduction of animal life. The plants employed for this purpose must of course be all natives of the sea, and fortunately such is the abundance and variety to be met with on every coast, that the difficulty lies in

the selection of the most beautiful and suitable specimens.

There is wide room here for consulting the picturesque: some humbler forms of sea-weed clothe the rocks with moss-like softness, or hang like tapestry upon the shelving walls;

"Others, that like the broad banana growing,
Raise their long wrinkled leaves of purple hue
Like streamers wide outflowing;
Trees of the deep, and shrubs, and fruits, and flowers
As fair as ours,
Wherewith the Sea-nymphs love their hair to braid."

These are, however, only to be procured in a healthy and vigorous condition whilst growing in their native haunts; it is useless to pick them up upon the beach; they must be gathered where they grow, and that can only be done, generally speaking, at low-water mark, —the lower the tide the better. Here, in some wave-deserted pool, whose sides are overgrown with Algæ of a hundred different kinds and varied hues, the naturalist must take his choice among the rich profusion, although he will doubtless find the following hints thrown out by Mr. Gosse, of material assistance whilst making this selection:—

"The first thing to be done is to obtain the Algæ in a growing state. As they have no proper roots, but are in general very closely attached to the solid rock, from which they cannot be torn without injury by laceration, I have always used a hammer and chisel to cut away a small portion of the rock itself, having ready a jar of sea-water, into which I dropped the fragment with its living burden, exposing it as

little as possible to the air. The red sea-weeds I have found most successful. Fuci and Laminariæ, besides being unwieldy and unattractive, discharge so copious a quantity of mucus as to thicken and vitiate the water. The Ulvæ and Enteromorphæ, on the other hand, are apt to lose their colour, take the appearance of wet silver-paper or colourless membrane, and presently decay and slough from their attachments. The species that I have found most capable of being preserved in a living state are, *Chondrus crispus*, the *Delesseriæ*, and *Iridea edulis*. The last-named is the very best of all, and next to it is *Delesseria sanguinea*, for maintaining the purity of the water, while the colours and forms of these render them very beautiful objects in a vase of clear water, particularly when the light, as from a window, is transmitted through their transparent fronds."

In a communication made by Mr. Warington to the British Association*, he stated that the result of his experiments to ascertain the kind of sea-weed best fitted for maintaining the balance with animal life in a vivarium, was, under ordinary circumstances, in favour of the CHLOROSPERMS, or green sea-weeds; and that the RHODOSPERMS, or red sea-weeds, submitted to the like conditions, did not answer the purpose desired, and at the same time retain their colour and beauty, inasmuch as they very soon become coated with a growth of short and brown Confervæ (*Conferva tortuosa*?), which entirely mantled the whole surface of the fronds, and destroyed their characteristic appearance. During these investigations, however, it

* Ann. Nat. Hist. 1854.

occurred to him that it might be possible to obviate such a drawback, and at length he succeeded, after a number of experiments, in overcoming this inconvenience, and in retaining them, in all their natural loveliness, efficient for the purposes required; that is, as consumers of carbonic acid and generators of oxygen.

The considerations on which these experiments were founded, were based upon the circumstance that nearly the whole of these red or pink-coloured sea-weeds are found either in deep water or under the shade of other Algæ; whilst, from the fact that they are often also known to occur in shallow rock-pools, it seemed fair to assume that the pressure of the superincumbent column of water could not be an important element in the production of these coloured growths, and therefore that it must depend upon a modification of the light. Hence, Mr. Warington conceived the idea that the effects of the depth of water might be imitated by tinting the light through the interposition of coloured media; and thus all the results observed in the vegetation, and much even of the healthy animal life of deep sea-water, could be, under this arrangement, assimilated; so that by very simple means and very little trouble, we might be enabled to grow and preserve for any length of time these elegant and beautiful plants in all their varied hues, as well as many of the wondrous forms of animal life associated with them.

In order to obtain this desideratum, a medium having a blue or green tint, and of such a nature as merely to colour, soften, or diffuse the light without materially diminishing its quantity, has been had recourse to. This may be accomplished by the employ-

ment of thin silk gauze of a blue colour, or by layers of tissue-paper tinged blue and green, sometimes oiled to make them more transparent; or coloured varnishes, blue, and blue and yellow, mixed to the required tint, will answer the same purpose. These materials should be applied to the surface of the glass, or interposed between the source of light and the water in such a way, that the whole of the light which directly illuminates the aquarium may be tinted of the proper colour.

To such an extent has this plan succeeded, that portions of red sea-weed, which had become thickly mantled with the brown and green confervoid growths above alluded to, and which had not exhibited the least signs of vitality, on being placed in a small glass jar, arranged with tinted and oiled tissue-paper, soon lost the whole of this parasitic growth from its gradually decaying, and being then consumed by the mollusks; the fronds, assuming their deep crimson hue, becoming perfectly clear, and throwing out new shoots and leaflets.

Sea-water may be preserved for a long period in a perfectly efficient and healthy state under some circumstances without the introduction of growing vegetation, and this simply by exposing a very extended surface to the action of the air, and at the same time limiting its depth.

The means whereby this may be accomplished, consist in the employment of shallow circular stoneware pans of about eighteen inches internal diameter by five inches deep; these are filled for about two inches with water, the bottom is supplied with sand and

shingle, and numerous fragments of rock-work may be arranged at the sides, some close below the surface of the water, others rising in gentle slopes above, and others, again, grouped to form cavities of retreat, so as to accord with the habits of Crabs, Blennies, &c., which may be placed in them. The whole can be covered with a sheet of common window-glass raised about a quarter of an inch from the edges of the pan by means of slips of wood, so as to allow a free current of air over the surface of the water, and at the same time impede the evaporation and prevent the greater part of the dust and soot from settling on it. By this arrangement a very extended surface of water is submitted to the absorption of air, and the fish and crabs, by their continual movements, cause sufficient motion in the fluid to expose a fresh surface frequently to its action, and thus keep up its aëration. But it must be borne in mind, that the oxygenization of water thus effected is a very delicate equilibrium, and the maintenance of a healthy aëration is liable to be disturbed by very slight intervening causes; indeed, practically, this method is only applicable to such marine denizens as require but little aëration of the medium they respire, or to such as the Crab tribe, the Blennies, Cotties, Gobies, and creatures which delight in very shallow water, or which have the power of climbing out of their liquid element.

Having stocked our tank with appropriate vegetation in sufficient abundance, it only remains to represent the *scavenger department* by introducing a few hungry mouths to browse upon the rank luxuriance of vegetable growth, and to keep in check the

production of those green slimy protophytes, with which, without such interference, the glass sides of the aquarium would speedily become coated over, and the view of its contents, of course, proportionably obscured. In the freshwater tank we find this important duty to be efficiently performed by a few vegetable-eating Snails, and in sea-water it is fortunately by no means difficult to avail ourselves of a similar agency. The common Periwinkle, met with abundantly on every rock, will be found most useful for this purpose; and if other vegetable-eating species can be obtained of gayer colours, or more interesting character, so much the better—only let their number be carefully adjusted to the work required to be performed.

All things being now in readiness, it but remains to furnish the aquarium with appropriate occupants, and in doing this, of course everything will depend upon the opportunities or intentions of the proprietor. Wide is the field, ample the store from which to choose—sometimes, indeed, too tempting. The great danger is in overdoing this part of the arrangement, in being too greedy for novelties—a fatal error, which surely brings its own punishment. It is difficult to lay down any precise rule for the guidance of the young aquariist—experience will soon teach the *juste milieu,* which must be strictly kept. It is much better to have few specimens in the tank than one too many. Should any specimens die, let them be instantly removed; and be careful not hastily to fill up their places, unless quite sure that overcrowding is not the cause of the mortality. A long glass tube,

or a pair of forceps, with which the bottom of the tank can be easily reached, should always be at hand wherewith to take away whatever dies, and thereby save the rest.

Another source of loss arises from the creatures attacking and devouring each other, and it therefore becomes a point of great importance, and highly necessary to be carefully observed where their preservation is an object, to ascertain what varieties may be safely associated in the same tank. Shrimps and Prawns attack and very soon devour all the larger varieties of Corallines and Polyps, Sabellæ, Serpulæ, Rock-borers, Cirrhipeds, and some of the Annelids, as well as many Bivalve and Univalve Mollusks that are unprotected by an operculum, or have no power of closing their valves.

The common Crab (*Cancer Mænas*) is a most destructive fellow, and the tribe of Rock-fish, the Blennies, Gobies, &c., are also awfully voracious, devouring all the varieties of Cirrhipeds, Corallines, Polyps, Annelids, &c.; they will also attack the Shrimps and Prawns, and even seize upon the horns of the Periwinkle, which they bite. If the Mollusks do not keep a very firm hold of the rock or tank-sides, they are rapidly turned over on their backs by these fish, and lie helplessly exposed to their attacks. It becomes necessary, therefore, in consequence of such ravenous propensities, to separate these various depredators from each other; and in one tank to place varieties of Actiniæ, Shrimps, Nudibranchs, Holothuriæ and Annelidans; in a second, the Rock-fish, such as Blennies, Gobies, Cotties, &c., with Crabs and

Actiniæ; in a third, Corallines, Annelids, Polyps, Rock-borers, Sabellæ, Serpulæ, Holothuriæ, Actiniæ, and so forth—classifying with care the occupants of each tank according to their various habits.

Temperature* is a point of great importance. The mean temperature of the ocean is estimated to be about 56° Fahr., and this under ordinary circumstances does not vary more than about 12° throughout the different seasons of the year.

Many of the inhabitants of the sea are very sensitive to changes of temperature, and we find that a few degrees of variation will cause them rapidly to move their position, and seek some cooler or warmer spot, as the case may be. In the ocean it will be evident that the creatures have the power readily to effect this, under ordinary circumstances, by seeking deeper water, not liable to be affected by atmospheric influences, by partially, or entirely, burying themselves in the sand or shingle, or by shielding their bodies under the protecting shadow of the rocks, or growing vegetation. In arranging the rock-work in the interior of the aquarium, therefore, great care should be taken to keep these points in view, and to afford as much protection as possible to the creatures from the cooling influences of radiation on the one hand, and from the heat of the sun's rays upon the other. "From my own experience," says Mr. Warington, "I find that the range of temperature should not be below 50° Fahr., nor above 70°. Within these limits all appears to progress healthily; but beyond these points many of the creatures are rapidly affected.

* Warington, Ann. Nat. Hist. 1855.

During the last long-continued severe winter it was found very difficult, in an ordinary sitting-room having a south aspect, and a good fire maintained throughout the day,—the tanks being also screened at night by a blind,—to prevent the powerful cooling effects from radiation on a clear frosty night; and on three several occasions, marking exactly the three severest frosts that we experienced during the winter, the thermometer immersed in an aquarium containing about thirty gallons of water fell as low as 45° Fahr. The Shrimp and Crab tribes, and the Crustaceans generally, are especially affected by these changes, and on each of the three occasions alluded to one or two individuals perished."

Excess of heat, and also strong sunlight, are likewise to be as carefully guarded against, and the exposure of a small tank to the direct rays of the sun on a hot summer's day, will speedily result in the destruction of every animal in it.

Too much light has also the effect of rapidly causing the propagation of microscopic Infusoria of a green colour, such as *Euglena* and its congeners, which, under this influence, multiply so rapidly as to render the whole water turbid and opaque. These will sometimes subside to the lower part of the tank, as evening approaches, and disappear in the shingle bottom; but immediately the morning light shines strongly upon the aquarium, they will rise like a thin green cloud, and diffuse themselves throughout the water. Although this Infusorial growth is not unhealthy, yet it causes the aquarium to present a very unsightly appearance, and prevents all observation on

the habits of its inmates. The want of light, on the other hand, causes the rapid decay of the vegetation, and the products arising from this change are highly poisonous to animal life,—the whole contents of the aquarium becoming of a black colour, and very soon of an offensive odour.

All marine productions dislodged from considerable depths are liable to injury. Though casually obtained clean and entire, most of them are profusely invested with parasites, which, fatally and invisibly wounded, speedily corrupt the circumambient fluid in their decay. The water also sometimes contracts a noxious principle from causes eluding conjecture and observation, and it may be fit to warn the inexperienced naturalist against employing tall vessels with much empty space above the water on all occasions; for if the air vitiated by respiration, after escaping from the surface, be reabsorbed, it cannot be otherwise than deleterious. This is well illustrated by keeping fishes in deep vessels with a scanty proportion of water, to prevent their leaping over the side; they generally perish in a short time, and hence shallower vessels nearly full are always preferable.

It is sometimes advisable to suspend delicate or interesting zoophytes, more especially of the Tubularian or Sertularian races, by means of silken threads attached to pieces of cork, which may be allowed to float upon the surface of the tank. This is a method often to be particularly recommended, both for convenience and security: the subject is better preserved; the specimens are more accessible, should they be required for microscopic examination, and by immediate

transference they can always be kept in the purest available medium.

Artificial aëration of the water contained in an aquarium may sometimes be beneficially adopted, provided it can be employed without danger of disturbing delicate productions, or injuring the more tender inmates. A simple way of effecting this, and one that we employ with excellent results, is by the use of a small garden watering-can with a very finely perforated "rose," such as is used for watering choice flowers. This we fill with water taken gently from the tank, which we pour back again from a sufficient height, like a refreshing shower sparkling with vital air.

And now, gentle reader, let us hasten to the beach: the tide is near its ebb, and yonder rocks, baring their shoulders to the sunshine, seem to rest themselves in grim repose.

> "All the broad bosom of the ocean keeps
> An equal motion; swelling as it sleeps,
> Then slowly sinking: curling to the strand,
> Faint, lazy waves o'ercreep the ridgy sand,
> Or tap the tarry boat with gentle blow,
> And back return in silence, smooth and slow."

This is the time for work. Come, boy! the fishing-basket and the muslin landing-net—a hammer and an iron chisel. Mind, too, you don't forget the large glass jar with handles made of rope, wherein to put what specimens we find.

CHAPTER II.

"And here were coral bowers,
And grots of madrepores,
And banks of sponge, as soft and fair to eye
As e'er was mossy bed
Whereon the Wood-Nymphs lie
With languid limbs in summer's sultry hours."

SPONGES.

Among the most unobtrusive, but by no means the least interesting productions of the sea-shore, and, moreover, obtainable abundantly from the rocks of every beach by any one who chooses to select these elegant organisms to form a living carpet for the naked rock-work of the aquarium, are the Sponges, a race of beings dubiously interposed in the classification of the modern naturalist between the animal and the vegetable departments of creation.

It is not known under what pressure of the ocean these delicate creatures may live*, but they are found equally in places covered perpetually by the sea, as in those which it leaves dry at every recess of the tide. They adhere to, and spread over the surface of rocks, sea-weeds, marine shells, and many other objects, to which they are so firmly attached, that they cannot

* Professor Grant, Ed. New Phil. Journ.

be removed without lacerating or injuring their substance. Although they thrive best in the sheltered cavities of rocks, they come to maturity in situations exposed to the unbroken fury of the surge; but in the latter situations Dr. Grant observes that they are smaller, and firmer in their texture, like those inhabiting colder climates, and this whether their exposure be to the north or south. They cover the naked sides of cliffs and boulders; they line with a variegated and downy fleece the walls of submarine caves, or hang in living stalactites from their roofs. In fact, they attach themselves indiscriminately to bodies belonging to the mineral, vegetable, and animal kingdoms, and the individual species seem to have no law with regard to the particular substances to which they adhere.

The branched Sponges are usually to be met with hanging perpendicularly from the under and sheltered surface of solid overhanging cliffs, or tabular masses of rock. The flat, spreading species with projecting papillæ are generally found on the sides of boulders; while flat specimens, without prominent papillæ, are more frequently seen on the under surfaces of stones, or else enveloping bodies which admit of a little motion by the agitation of the sea.

The delicate and beautiful *Spongia compressa* is sometimes found hanging from the surface of Ascidiæ, or of flat sponges, as likewise from the rock itself. The *Spongia coalita* is a branched species capable of rising erect, owing to the great breadth of its base, the firmness of its skeleton, and the frequent anastomoses of its branches.

In their natural state the Sponges are soft and elastic, and some of them are tinted with lively colours; but many of the species, by drying, become quite friable, lose their fine shades of colour, and grow white. Soon after death they pass through a bluish colour to black, in consequence of putrefaction; and when this occurs, we need hardly say the more speedily they are removed from the aquarium the better.

They seem to grow best near the shore; yet even Aristotle speaks strongly of the injurious effects of high temperature on these animals, and says that it causes them to run rapidly to putrefaction,—a remark which any of our readers who may be desirous of keeping sponges alive will find it useful to remember, more especially as the same remark is equally applicable to a vast number of the humbler zoophytes.

It would hardly be supposed by any casual observer, that beings apparently motionless and inactive as the rocks on which they grow, should possess much interest beyond what attaches itself to their variety of form and delicacy of structure, and yet few creatures exhibit phenomena more wonderful.

"In the month of November," says Professor Grant, "I put a small branch of the *Spongia coalita* (Pl. I. fig. 1, *a*), with a little sea-water, into a watch-glass, and placed it under the microscope; when, on reflecting the light of a candle up through the fluid, I soon perceived that there was some movement going on among the opaque particles floating through the water. On moving the watch-glass so as to bring one of the apertures on the side of the sponge fully

PLATE I

into view, I beheld, for the first time, the splendid spectacle it presented,—a living fountain vomiting forth from a circular cavity an impetuous torrent of fluid, and hurling along in rapid succession opaque masses, which it strewed everywhere around. The beauty and novelty of such a scene in the animal kingdom long arrested my attention; but after twenty-five minutes of constant observation, I was obliged to withdraw my eye, from fatigue, without having seen the torrent for one instant change its direction, or diminish in the slightest degree the rapidity of its course. I continued to watch the same orifice, at short intervals, for five hours, sometimes observing it for a quarter of an hour at a time, but still the stream rolled on with a constant and equable velocity. About the end of this time, however, I observed the current become perceptibly more languid,—the opaque flocculi which were thrown out with so much impetuosity at the beginning were now propelled to a shorter distance from the orifice, and fell to the bottom of the fluid within the sphere of vision, and in one hour more the current had entirely ceased.

"On attempting to examine some of the larger flat species, as the *Spongia panicea* and *Spongia cristata*, in the same manner with the microscope, I found it not so practicable. The dissection necessary to reduce them to a size suitable for examination under that instrument, threw open their canals so much, as to destroy their means of manifesting a concentrated current. But a single papilla, torn from a *Spongia papillaris*, or other spreading sponge which has the papillæ much elevated, shows distinctly this interest-

ing phenomenon when placed in a watch-glass with sea-water under a microscope.

"The *Spongia panicea* presents the strongest current which I have yet seen, and has the greatest thickness of body of any spreading sponge which I have met with on the rocks of this part of the Frith of Forth. Two entire round portions of this sponge were placed together in a glass of sea-water, with their orifices opposite to each other at a distance of two inches; they appeared, even to the naked eye, like two living batteries, and soon covered each other with flocculent matter. I placed one of them in a shallow vessel, and just covered its surface and highest orifice with water. On strewing some powdered chalk on the surface of the water, the currents were visible to a great distance; and on placing some pieces of cork or of dry paper over the apertures, I could perceive them moving by the force of the currents, at the distance of ten feet from the table on which the specimen stood. A portion of soft bread, pressed between the fingers into a globular form, with a diameter larger than that of the orifice, and placed over it, was not moved away in a mass by the stream, but was gradually worn down by the current beating against its sides, and thus propelled to a distance in small flakes. A portion of unburnt coal, twice the diameter of the orifice, was instantly rolled off the mouth of this living fountain, in whatever position I attempted to make it rest upon it. A globule of mercury of equal diameter with the orifice, let fall upon it through a glass tube, was not removed nor shaken, and completely stopped the current. I now pierced with a needle a

thin superficial canal in the vicinity of the closed aperture, and established a new current, which continued even after the removal of the obstruction."

Nothing is easier than the repetition of the above interesting experiments. The entire surface of the sponge is seen to be perforated by innumerable pores and apertures, some exceedingly minute, opening on every part of its periphery; while others, of larger dimensions, are placed at intervals, and generally elevated upon prominent parts of the mass. Through the countless smaller orifices the surrounding water is continually sucked, as it were, into the interior of the spongy mass, and it as constantly flows out in continuous streams through the larger openings. Organized particles that everywhere abound in the water of the ocean are thus introduced on all sides, and are doubtless employed as nutriment, whilst the superfluous or effete matter is continually cast out with the issuing streams as they rush through the larger orifices.

On examining a specimen of growing sponge during the months of October and November, a remarkable change may be observed to have taken place in its internal texture. The parts which in summer were transparent and nearly colourless, have now become everywhere studded with opaque yellow spots, visible to the naked eye (Pl. I. fig. 1, *a*), and without any definite form, size, or distribution, save that they are most abundant in the deeper parts of the sponge, and are seldom observable at the surface. By examining thin sections with the microscope at this period, it is found that these bright yellow spots consist of groups

of very minute gelatinous granules, which lie imbedded in the soft substance. These yellow granules are the rudiments of the eggs, or *gemmules*, of the sponge, and when they are first perceptible by the aid of a microscope, they consist only of a small, round, compact group of the same gelatinous-looking bodies which compose the living portion of the mass; but as they arrive at maturity, they assume a regular form; and when mature, are washed out of the body of the parent by the issuing currents, ready to become dispersed wherever the presence of the species may be made available for the beneficent purposes of Nature.

But here a difficulty presents itself, which at first sight might well be regarded as insurmountable. The parent sponge, deprived itself of all power of moving from place to place,—fixed and motionless as the rock on which it grows,—must obviously be incapable of distributing to a distance the numerous progeny which it furnishes; and without some special provision for the purpose, they could only have accumulated in the immediate vicinity of their place of birth. The seeds of vegetables, sometimes winged and plumed for the purpose, are blown about by the winds, or transported by various contrivances, to distant localities; but in the present instance such a mode of proceeding is out of the question, and as germs so soft and delicate could hardly be removed by the agency of other animals, by what possible means are the young sponges to become disseminated through the ocean?

It is said that a heathen philosopher,—old Galen, we believe,—a declared sceptic and atheist, happen-

ing one day in his travels to stumble upon a human skeleton, and being induced to contemplate rather more closely than he had ever done before the wondrous mechanism displayed in its construction, suddenly ejaculated, "*Hic Dei manus videtur*!"—"Here truly I can trace the hand of God!" There were no microscopes in Galen's time, neither had he ever an opportunity of witnessing ciliary action, or he would hardly, we think, have lived so long and gone so far without recognizing the finger of Omnipotence. "*Ciliary action*!" exclaims our friend, "pray what is that?" and as some of our readers may perhaps feel disposed to make the same inquiry, we will pause a moment to explain the meaning of an expression that must recur continually in future pages.

On placing a few of the gemmules of a sponge above mentioned, which, in size and shape, might not inaptly be compared to minute pins'-heads, in a watch-glass containing a little sea-water, it will soon become evident, even to the naked eye, that they are able to swim about with considerable facility; but how they manage to accomplish such a feat is by no means so easily discernible. On examining them, however, with a good microscope, the machinery employed for the purpose becomes revealed to sight; and certainly a spectacle more wonderful imagination scarcely could conceive. Millions of paddles, furiously at work, bestud the surface of these tiny atoms,—so rapid in their motion, that the eye almost refuses to perceive their shape; so manageable, that their action seems directed by one impulse; and yet so minute, that words in vain attempt to tell their

almost imperceptible dimensions. The word *cilia*, whereby these miraculous organs are now universally designated, is, as we need scarcely say, derived from their resemblance to rows of eye-lashes (*cilium*, an eye-lash); but the most rapid wink will not express the quickness of their motion.

The gemmules of the sponge are somewhat egg-shaped (Pl. I. fig. 1, *b*), and cilia cover every part of their surface, excepting their posterior tapering extremity. In swimming, they always carry their broadest end foremost. They have a granular structure, and in some species minute spicula, resembling those that constitute the framework of the adult sponge, are distinctly discernible at the time of their expulsion. They do not change their form while swimming, like those of many other zoophytes, but glide along with a regular smooth motion. After remaining some time in the water, they generally come to the surface, and collect round the margin of the vessel. These gemmules often continue to swim about, by their own spontaneous movements, for two or three days after their detachment from their parent, as though in search of a suitable locality whereon to rest; at length they are to be observed beginning to fix themselves on the sides and bottom of the tank, and some of them are found spread out like a transparent membrane on the surface of the water. When examined through a microscope, while in the act of attachment to the glass, each gemmule may be seen to extend itself into a thin circular film; still the cilia may be observed in rapid motion on the upper part, propelling the floating particles in their neighbourhood to a

distance. They soon, however, become languid, and in the course of a few hours they cease to move. Spicula now begin to make their appearance in the transparent film; and in a few weeks after the gemmule has become fixed, these spicula become aggregated into bundles: at particular places, towards the centre, they soon present circular arrangements, and distinct openings are at length perceptible by the aid of a microscope in these enclosed spaces. The ova now spread and enlarge in every direction, and even before they exceed a line in diameter, evidently present through the microscope a marked resemblance to the parent sponge.

CHAPTER III.

"The majesty of God appears no less in small things than in great: and as it exceedeth human sense in the greatness of the universe, so also it doth in the smallness of the parts thereof."

FORAMINIFERA.

We will now suppose our tank to be complete, at least as far as relates to preliminary arrangements; our sea-weeds have become habituated to their new abode, and sponges clothe our mimic rocks with a soft living carpet; the water has been left to settle undisturbed, and is as clear and bright as crystal, so that we are tempted more minutely to inspect our new domain.

In this condition, if, with the assistance of a magnifying-glass, we closely examine the glass walls of the aquarium, we shall not unfrequently find numerous little shells adherent to their interior, which, although exceedingly minute, are well calculated from the elegance of their form to arrest attention (Pl. I. fig. 2). They might, indeed, almost be mistaken for the shells of little Nautili, both from their shape and from the circumstance of their being divided into chambers; in size they are little larger than small pins'-heads, and hence might easily escape the notice of the unobservant.

Examined still more attentively, these elegant shells are found (especially if examined in a dry state) to be perforated all over with minute holes, and that to such an extent, that the term FORAMINIFERA, by which animals of this description are generally designated, is perhaps as distinctive as any other that has been proposed for them.

Few creatures are more simple in their structure than these Foraminifera. Examined in a living state, such as they present themselves while adherent to the sides of the aquarium, their substance seems entirely composed of most translucent jelly, filling up the chambers of the camerated shell,—jelly so soft and semi-fluid, that it issues forth through all the apertures that crowd the superficies like subtle threads of molten glass spreading upon the surface of the tank, and evidently all endowed with life and motion. A sight more wonderful than these transparent beings, creeping with their root-like legs, can scarcely be imagined.

Simple as is their structure, the Foraminifera are moreover eminently voracious, and devour in great numbers the humbler organisms with which they share the drops of water around them. On dissolving the shell of one of these remarkable animals by immersing it in a little diluted acid, completely denuded of its outer covering (Pl. I. fig. 2, *a*), its soft transparent body is then seen to consist of several segments, corresponding with the compartments of the shell, in each of which the remains of Bacillariæ, Desmidiæ, and similar beings, are readily distinguishable, proving at once both its destructive appe-

tite and its capabilities of digesting food, although how such food is swallowed is a puzzle.

Innumerable are the forms under which these Foraminifera present themselves, each rivalling the other in delicacy of structure and elegance of shape; and if we have selected but a single species as an illustration of their structure and habits, we can assure the reader it is by no means on account of deficiency either in the variety or the number of specimens at our disposal. True it is, that not many years ago the very existence of such beings was unknown even to the scientific naturalist; much less did any one suspect that these unseen, these unobtrusive agents were employed in building up the very world on which we tread. Nay, start not, reader; what at first may seem a rash assertion, will bear thorough sifting: to convince yourself, take but a handful of the sand cast up by the retreating tide upon the nearest beach, and, with a pocket lens, examine it minutely,—count the various forms you there encounter; and, if you have sufficient patience, count their numbers too,—no easy task sometimes.

The sand of most sea-coasts is, indeed, so filled with these microscopic Foraminifera, that it is often composed of them to the extent of one-half. Plancus counted 6000 in an ounce of sand from the Adriatic Sea, and D'Orbigny, the great historiographer of these minute organisms, reckoned 3,840,000 in an ounce of sand from the Antilles. If we calculate the contents of larger quantities, as, for example, a cubic yard, the amount surpasses all human conception, and we have difficulty in expressing the resulting number in figures;

and yet how insignificant the sum, when we regard, in the same point of view, the enormous mass constituting the sea-coasts of the earth! The researches of D'Orbigny relative to these microscopic organisms go to prove that the remains of Foraminifera constitute, in a great measure, banks, which by their accumulation interrupt the progress of the navigator, stop up bays and straits of the sea, fill up harbours, and, together with various corals, produce those islands that rise up in the warm regions of the Pacific Ocean.

But more than this,—the almost invisible shells we are now contemplating have had to do with the construction of the surface of the earth, and it is easy to adduce facts to show that they contribute much to the formation of vast geological deposits. Take, for example, as a striking case, the environs of Paris. The *calcaire grossier* of that extensive basin is in certain places so filled with Foraminifera, that a cubic inch from the quarries of Gentilly contains something like 58,000 of their shells, and that in beds of great thickness and of vast extent. This gives an average of about 3,000,000,000 for the cubic yard,—a number so great as to put a stop to all further calculation. Now, as all Paris, and the towns and villages of the neighbouring departments are built of stone quarried from this deposit, it is evident that, without exaggeration, the capital of France, and all the neighbouring towns, are constructed principally of the shells of Foraminifera.

Again, the remains of the Foraminifera are not less abundant in the tertiary formations extending from Champagne to the sea, as also in the basins of the

Gironde, of Austria, and of Italy, &c. The chalk of our own country, throughout its vast thickness, contains myriads; and thus have these shells, which are from their minute size hardly perceptible to the naked eye, not only altered the depths of the actual ocean as it now exists, but also, previously to our epoch, formed mountains and filled up basins of great extent.

We must ascribe the obscurity in which the Foraminifera have remained to the difficulty of observing them; and yet there are few branches of study more accessible to every one, and which afford more important consequences. Should an observer be resident on any coast whatever, in any quarter of the globe, or on any tertiary, chalk, or oolitic formation, he will find everywhere under his feet a multitude of Foraminifera, for whose examination a simple lens is sufficient, and whose study possesses equal interest both for the geologist and the zoological student.

CHAPTER IV.

"See, as they float along, the entangled weeds
Slowly approach, upborne on bladdery beads;
Wait till they land, and you shall then behold
The fiery sparks those tangled fronds infold—
Myriads of living points; the unaided eye
Can but the fire, and not the form, descry.
And now your view upon the ocean turn,
And there the splendour of the waves discern:
Cast but a stone, or strike them with an oar,
And you shall flames within the deep explore;
Or scoop the stream phosphoric as you stand,
And the cold fire shall flash along your hand;
When, lost in wonder, you shall walk and gaze
On weeds that sparkle and on waves that blaze."

NOCTILUCA.

READER, in thy enthusiasm for natural history, has it ever been thy fate to lose thyself on a dark night upon the Yorkshire coast? if not, let me give thee timely warning that such an accident is neither good for thy comfort or thy health.

It was a glorious morning when I one day started alone from Whitby upon a naturalizing expedition, purposing on that occasion to make my way as far as Scarborough before night. It was only thirteen miles, I was told, and an excellent road all the way. Hammer

in hand, therefore, I set out, and with a fishing-basket at my back and a wallet at my side, was prepared for anything that might occur. The Lias cliffs with their rich stores of Ammonites and Belemnites were on one side of me; the Black-Scar with its periwinkles (*covins* they call them there) and the sparkling sea on the other. Merrily the waves rolled in, and cheerfully they dashed themselves in spray upon the sable crags. Brightly shone the sun upon the venerable pile of St. Hilda as I passed beneath its sculptured aisles—a noble landmark, welcome to the eye of many a weary sailor, and the sea-birds as they circled round my head seemed to bear me welcome company. On I went, dividing my attention pretty equally between the present and the past—sometimes gathering living mollusca among the sea-beaten rocks; sometimes exhuming Ammonites (the snake-stones of the Whitby banner) from their awful graves; sometimes, as the approaching tide came up, wetting my feet in the advancing foam, and then again approaching the gigantic cliffs, peeping about in hopes of descrying the tail of a Teleosaurus projecting from their wave-beaten front—when suddenly, as the distance between the margin of the sea and the face of the cliff began sensibly to diminish, it became apparent that the tide was rapidly coming in, and on looking forwards toward the next headland, against which the waves were already breaking, the agreeable conviction flashed upon my mind that further advance was barred. Judge however, gentle reader, what were the feelings with which, on turning to go back, I saw that to retreat was equally out of the question, and that, moreover,

the grim wall that towered above my head seemed about as climbable as the Duke of York's column. Matters certainly began to look serious;—I thought of Sir Arthur Wardour and his daughter in the 'Antiquary,' and would have given something to be assured that another Edie Ochiltree or anybody else had seen me enter so perilous a strait; but there was little chance of that, and it soon became evident that my fate depended on my own exertions. On I pushed, surveying now those cliffs with very altered looks, and feelings by no means enviable. At length I reached a place apparently more practicable than elsewhere—at least there was no choice: to climb or drown were my alternatives—and fortunately I at length succeeded in scaling a height sufficient for my purpose, and perched myself like a sea-bird upon a ledge of rock. There was nothing for it but to sit there patiently and thankfully, asking myself—

"What are the wild waves saying?"

until the tide receded—weary hours they were—but at length they passed, and I again saw the yellow sand beneath me, and recommenced my journey. I had, however, had enough of the seashore for that day, and a few miles further on was enabled to gain the summit of the cliff. It was now growing towards evening: no house appeared—nothing but a bleak expanse of moor; it was getting dark, and to add to my discomfort, it began to rain; on I trudged, as long as the direction in which I was going could be seen; but when this was no longer distinguishable, very disagreeable anticipations as to the future pre-

sented themselves: on one side was a precipice some three or four hundred feet high, and at its feet rolled the sea, from whose rapacious waves, that seemed to be still roaring after their prey, I had so narrowly escaped; upon the other side lay a wild Yorkshire moor; a false step in one direction would have been instant death, and any step in the other apparently very useless, and certainly dangerous. To lodge on the cold ground seemed therefore the safest and wisest plan; hungry, tired, and moreover wet to the skin, I sat me down, doubtless as melancholy and disconsolate an object as could well be imagined.

But my destiny was not to be quite so bad as I anticipated; a glimmer of light became perceptible at some distance directly inland—it was no will-o'-the-wisp to tempt me over the cliff, I was quite sure of that—cautiously I advanced towards it, gathering more courage as I felt myself more remote from that dizzy height, and at last succeeded in procuring a guide to Robin Hood's Bay.

It was nearly midnight when, under the safe conduct of my escort, following a tortuous and steep descent, we reached the beach in that secluded nook, and there beheld a scene not easily forgotten.

Few visitors to the sea-side have not, at some time or other, more especially during the summer season, had occasion to observe, while walking by night upon the shore, or else, while enjoying the breeze upon some pier-head or sea-overhanging cliff, a phenomenon as beautiful as it is astonishing. The waves, as they come rolling in, seem fringed with fire; and when they break upon the shore, burst into liquid flame which

glides along, still spreading as it flows, until it laves the sands with light, and then slowly retiring, leaves a track of shining sparkles glittering on the strand. If witnessed from a boat, or from a steamer's deck, the scene is still more wonderful: the heaving waves around appear to burn like phosphorus, emitting pale and ghostly splendour; the silent oars are raised dripping with living diamonds; or if a hand should be immersed in the refulgent water and again withdrawn, the glowing sparks, like tiny stars, stick to its surface, or are shaken off in brilliant scintillations. The splashing wheels stir up a sheet of light; the wake of the vessel flames behind as if it were the tail of some vast rocket, and the labouring ship appears to wallow in a fiery foam.

In our own climate, however, this luminous appearance is seldom witnessed in such perfection; more frequently, when the water is slightly agitated by the winds and currents, it only shows itself in scattered sparkles mingled with the spray of the sea, and in the froth created by the way of the ship. These sparkles or luminous points vary in magnitude, and often continue to shine for some moments as they pass the sides of the vessel or follow in its track. The kind of light thus exhibited is sometimes extremely brilliant, almost emulating that of the azure, gold, and silver rain of the pyrotechnist:—

"Beyond the shadow of the ship
I watch'd the water-snakes:
They moved in tracks of shining white;
And when they rear'd, the elfish light
Fell off in hoary flakes.

"Within the shadow of the ship
I watch'd their rich attire;
Blue, glossy green, and velvet black,
They coil'd and swam, and every track
Was a flash of golden fire."

This appearance is not unfrequently accompanied by flashes of a paler light and momentary duration, which often illuminate the water to the extent of several feet; these are more or less vivid according to the distance of the observer and the depth at which they make their appearance, resembling exceedingly the lightning so often seen in tropical regions, which presents itself in diffused flashes, now issuing from one mass of clouds, now from another, in constant succession over the whole face of the heavens.

The explanation of this phenomenon was to our forefathers simple enough, as any one may convince himself by referring to some of the earlier volumes of the 'Philosophical Transactions,' where, after elaborate theories relative to "phlegm" and "phlogiston," and other elements unknown in modern chemistry, the sages of those times ascribe all this luminous splendour to the "saltness of the sea:" and even in our own days, should the inquisitive passenger on board a vessel seek for information relative to the cause of the wide-spread phosphorescence, he will, in nine cases out of ten, receive a reply equally satisfactory, if not couched in precisely the same terms. A little careful examination will, however, soon convince the student of nature that such is by no means a true solution of the problem. A tumbler-glass filled from the glowing wave and set aside for accurate

inspection, will be found to swarm with little points of most translucent jelly, requiring close examination even to detect their presence, and yet so numerous that 30,000 of them have been calculated to be contained in a cubic foot of highly luminous sea-water. The appearance of these living gems the reader will find delineated in Pl. I. fig. 3, and during the summer season will have little difficulty in verifying the most prominent circumstances connected with their history.

The name *Noctiluca** conferred upon these minute organisms is indicative of the remarkable faculty that they possess of emitting a brilliant light. When a vase filled with sea-water, crowded with these little creatures, is placed in a dark chamber, the slightest agitation is sufficient to excite their phosphorescence, and the smallest undulations upon the surface are indicated by luminous circles. On examining one of them very attentively with a powerful microscope, it is further observable that the light given out is not universally diffused throughout the substance of its body, but is confined to minute shining points scattered here and there, which make their appearance in rapid succession, and as suddenly vanish: so that evidently there is no special organ to which the luminous appearance can be referred, as in the case of the glowworm and other phosphorescent creatures. In size, these stars of ocean are almost microscopic, the largest of them not much exceeding the dimensions of a pin's head; but the amazing numbers in which they crowd the seas amply make up for their minuteness; at certain seasons indeed it may be literally

* *Nocte*, by night; *luceo*, I shine.

said, that every drop of every wave contains one or more individuals belonging to the brilliant host. On taking up at random a flask of sea-water from any highly phosphorescent billow, and allowing the little creatures to accumulate, as they always do when at rest, at the top, it will be seen that their bodies will form a stratum equalling in thickness from one-seventh to one-third part of the entire contents of the vessel! After such a demonstration as this, it is easy to comprehend how the entire sea, rendered luminous by the presence of Noctilucæ, seems to burn with phosphorescent fire. When the surface of the water is tranquil in some well-sheltered bay, these living gems, rising from their low specific gravity to the top of the water, form a kind of cream of liquid light; or if a wave disperses their myriads through the mass of the sea, and at the same time calls forth, by agitation, all their brightness, it is easy to imagine how a flame is thus evoked that spreads for miles, giving, at a distance, the appearance of a uniform sheet of light, but when closely examined, resolvable, like the nebulæ in the firmament, into constituent stars.

Philosophers have been naturally anxious to discover the *object* of this curious property of emitting light. "Meditating upon this subject," says Mr. J. V. Thompson, "I think it not improbable that the Deity, who has done nothing in vain, and whose omniscience extends to every epoch, foreseeing that man would invent the means of tempting the trackless ocean, has given it as one means of rendering his nights less gloomy, and of diminishing the number of

his dangers; especially if we consider that this luminosity is seen only in the night season, is vivid in proportion to the darkness, disappearing even before the feeble light of the moon; and also that it increases with the agitation of the sea, so that during the prevalence of storms it greatly diminishes the dense gloom which at such times is often impenetrable to the moon or stars, throws such a light about the ship and rigging as to enable the sailors to execute their allotted tasks with certainty, and at all times points out to the cautious mariner the lurking danger of sunken rocks, shoals, and unknown coasts, by the phosphorescent or snowy appearance which it gives to the breakers, so as to render them visible at a considerable distance, or, where certain forms of it appear, lets him know that he is within soundings, and probably at no great distance from some fatal spot."

CHAPTER V.

"Awhile to wait upon the firm fair sand,
When all is calm at sea, all still at land;
And there the ocean's produce to explore,
As floating by, or rolling on the shore;
Those living jellies which the flesh inflame,
Fierce as a nettle, and from that its name;
Some in huge masses, some that you may bring
In the small compass of a lady's ring;
Figured by hand Divine—there 's not a gem
Wrought by man's art, to be compared to them;
Soft, brilliant, tender, through the wave they glow,
And make the moonbeam brighter where they flow."—

CRABBE.

ON MEDUSÆ, OR JELLY-FISHES.

FEW of our readers are unacquainted with the forlorn appearance of those gelatinous lumps which the retiring waves leave behind them upon the sea-beach, and which, under the euphonious names of "*Slobs*" and "*Slobbers*," or the still more appropriate appellations of "*Stingers*" or "*Stangers*," sometimes encumber the shore as their ice-like masses melt away before the sunbeams. Few, we hope, have not admired their graceful forms, when floating freely in their native element they could unfold their beauties to the eye, and show themselves such as they really are, the gayest, frailest, loveliest wanderers of the deep. It

is, indeed, difficult by any description at all to do justice to the appearance of beings so elegant, and we therefore gladly refer our readers to the accompanying drawings, in which some of their principal forms will be found very successfully delineated (Pl. I. figs. 4, 6, 7, 8, 9, 11 & 12).

The Medusæ* are to be sought for in summer and autumn, when the weather is warm and dry, and the sea calm and clear. They abound within reach, mostly in the afternoon and towards nightfall,—probably also during the night, though not then so near the surface of the water. A small bag of fine muslin attached to a metal ring is the best instrument with which to take them, and may be used either as a hand-net fixed to the end of a stick or rod, or as a tow-net suspended over the stern of a boat making very gentle way through the water. Beautiful specimens may likewise be obtained by attaching a tow-net to some buoy in a quiet bay and leaving it there during the night. The majority being oceanic, they are most numerous and varied on those parts of our coast which are touched by oceanic currents.

When the tow-net is taken out of the sea, it ought to be carefully reversed, and its contents gently emptied into a basin or glass jar filled with clear sea-water, and in so doing it is best to plunge the net beneath the surface of the water, as thus the Medusæ are enabled to detach themselves from the threads, and swim away without injury. When the net is out of the water, some scrutiny is requisite even to detect their presence; they appear like little, adhering, shapeless masses of

* Forbes, British Naked-eyed Medusæ.

clear jelly, and exhibit no traces of their elegant form and ornamental appendages.

Even when in the jar or basin, they are often, on account of their extreme transparency, very difficult to distinguish; but by placing them in the sunshine, or beside a strong artificial light, we see their shadows floating over the sides and bottom of the vessel, like the flitting clouds on a landscape. These soon guide us to the creatures themselves, and before long we distinguish their brilliant ocelli, and other coloured portions of their structure.

The next step is to secure such of the smaller species as we wish to examine closely, and transfer them to the watch-glasses or small phials. To do this is often not an easy task, for when alarmed they are exceedingly agile and alert; so that if we attempt to capture them with a tea-spoon, they usually escape, or if taken, owing to their slippery nature, slide out. This difficulty may be got over by using a small but deep glass spoon, with its handle set very obliquely, from which they are easily transferred to a watch-glass, and thus submitted to microscopic examination.

The Medusæ were known to the Greeks and Romans by the names of *πνεῦμα θαλάσσιον* and *Pulmo marinus*, which we may translate by *Sea-lungs*, on account of the constant rhythmical action of their gelatinous disc, which, alternately expanding and contracting, reminds the spectator of the heaving and subsidence of the bosom during respiration.

The movements of the Medusæ are slow, indicating that these creatures possess a very feeble amount of muscular energy; nevertheless they must be incessant,

seeing that the animals, their bodies being of greater specific gravity than the surrounding water, would inevitably sink were it not for the constant efforts of contraction and expansion which they exhibit. They swim by means of repeated approximations of the margins of the disc, whereby the water contained within and beneath the umbrella-like expansion is forcibly driven away, and the body of course impelled in the opposite direction; these efforts are leisurely repeated again and again, and should the back of the Medusa be horizontal, merely tend to keep it near the surface of the water; should, however, the convexity of the disc be inclined obliquely, by means of these movements the creature rows itself about with considerable rapidity; nevertheless the efforts thus made are very feeble, and the slightest current in the water is sufficient to carry such feeble animals out of their course.

All observers agree that the Medusæ feed upon small animals; and mollusca, worms, crustaceans, and even fishes, are stated to constitute their ordinary diet. We, however, advise any of our readers who may have the opportunity of so doing, to watch very closely this portion of their œconomy; and should they really be fortunate enough to feed any specimen, or even to see them seize and swallow prey, to note the circumstance, and thus clear up a point of no small interest to the natural historian.

Mr. C. W. Peach, in a communication read before the Royal Institution of Cornwall, mentions the capture of a minute Acaleph, *Thaumantias lucifera*, which had by some means caught hold of a Sagitta.

"Whether," says Mr. Peach, "it had employed the Sagitta to remove a bone which it had in its throat, after one of its delicate repasts, as the Wolf did the Crane, or not, I am unable to say; if so, the Medusa was not so honourable as the Wolf; for despite all the exertions of the Sagitta to free itself, and although the swallower's stomach was turned outwards during the struggle, it still refused to let the captive go; and the only difference that I could see was, the lips were pressed tighter round the head of his mouthful than before. No doubt the dread of separation rendered this tight embrace necessary, having met with a very rough customer. This appears to me to be proof positive that the Medusæ prey upon other animals, and do not hesitate to attack those of large size if they fall in their way; for I cannot believe this intrusion into the stomach of the Medusa arose from any Paul-Pry accident on the part of the Sagitta. It was a fearful struggle, maintained with great obstinacy on both sides, and which I watched for a quarter of an hour. I left them still locked at 2 A.M., hoping at daylight to see the result of the affair, but found that the vanquisher and the vanquished had both vanished, and left only a very minute granular wreck behind. This rapid destruction is not uncommon amongst the minute objects that swarm in the sea; for as soon as the least weakness or sign of decay takes place, the still smaller scavengers fall upon them, and in a very short time all trace of them is lost."

Professor Edward Forbes observes, that being kept in a jar of salt water with small crustacea, they not unfrequently devour these animals so much more

highly organized than themselves, voraciously; apparently "enjoying the destruction of the unfortunate members of the upper classes with a truly democratic relish;"—nay, some of them will even attack and proceed to swallow other Medusæ, in all respects quite as good as themselves. Yet are these ferocious creatures among the most delicate and graceful of the inhabitants of the ocean, —"very models of tenderness and elegance."

A very prominent feature in these animals, and that, indeed, from which, in almost all languages, they derive their popular designation, is their power of nettling or stinging the hands of the incautious experimentalist who may presume to lay hold of them, and that sometimes in a manner which fully entitles them to the names "Stingers" or "Stangers" above alluded to, or to the more refined epithets of *Sea-nettles, Orties de mer, Urtici marini,* &c., whereby they are distinguished in different countries; even the word ACALEPHÆ, by which, zoologically, the whole class is designated, has a similar signification. It is probable, however, that this offensive faculty of stinging is possessed by only a small minority of the sea-jellies. "Among them, the *Cyanea capillata* (Pl. I. figs. 11 & 12) of our seas is a most formidable creature, and the terror of tender-skinned bathers. With its broad, tawny, festooned and scalloped disc, often a full foot, or even more, across, it flaps its way through the yielding waters, and drags after it a long train of riband-like arms, and seemingly interminable tails, marking its course when the creature is far away from us. Once tangled in its trailing hair, the unfor-

tunate who has recklessly ventured across the monster's path too soon writhes in prickly torture. Every struggle but binds the poisonous threads more firmly round his body, and then there is no escape; for when the winder of the fatal net finds his course impeded by the terrified human wrestling in its coils, he, seeking no combat with the mightier biped, casts loose his envenomed arms, and swims away. The amputated weapons, severed from their parent body, vent vengeance on the cause of their destruction, and sting as fiercely as if their original proprietor itself gave the word of attack*."

Another remarkable property conferred upon the Medusæ is their power of shining in the dark with a phosphorescent splendour, surpassing even that of the Noctilucæ, and from their superior size rendering the jelly-fishes conspicuous objects even amid the galaxy of ocean-stars by which they are surrounded.

Any one who, on a dark night in the summer-time, has watched the waves whilst reclining over the side of a steam-boat, has doubtless often noticed the broad flakes of flame, which, kindled as it might appear by the rude shock of the revolving paddles, float astern, literally glowing with indignation. These fiery masses are, in truth, Medusæ, rudely roused while "peaceful slumbering on the ocean," and testifying thus their flaming wrath at such disturbance.

Even in the seas of our own climate, the phosphorescent light emitted by the Medusæ is extremely refulgent, and well-calculated to elicit the admiration of the beholder; but its brilliancy is far surpassed in warmer latitudes.

* Forbes, British Naked-eyed Medusæ.

If, says Spallanzani, in the beginning of the night we enter the Strait of Messina [October was the month in which these observations were made] in a low bark or boat, coasting near the land, where the water is perfectly calm, the Medusæ, usually very numerous, there begin to shine with a light which, as the darkness increases, acquires intensity and extent, every Medusa resembling a bright torch, that may be seen for some hundreds of paces round, and on approaching it the brilliant phosphorescence shows distinctly the form of the creature's body. This light, when the evening twilight is extinct, is of a lively white, which strikes the eye even when the animal is five-and-thirty feet below the surface. As the Medusa by its oscillation transfers itself from place to place, so the light is variable. Sometimes it continues for a quarter of an hour, half an hour, or more; but at other times, it suddenly becomes extinguished, and does not reappear till after a considerable interval.

We are indebted to Spallanzani for a great number of curious experiments upon this part of their history. That careful observer ascertained that the power of emitting light seems to be limited to the large arms or tentacles, the muscular zone of the umbrella-like disc, and the stomachal cavity, the rest of the animal only shining by transmitted light. He then endeavoured to find out the cause of this phosphorescent appearance, and ascertained that it is owing to the secretion of a peculiar glutinous fluid which exudes from the surface of the organs above mentioned. This secretion, even when mingled with other fluids, communicates to them a degree of phosphorescent

splendour. A single Medusa squeezed into twenty-seven ounces of cow's milk rendered it so luminous, that it was possible by the light which it emitted to read a letter at the distance of three feet from the glass containing the resplendent mixture. Even the living animal will communicate to the fluid in which it is plunged its phosphorescent property, and with much more brilliancy if placed in fresh water instead of salt.

Such are the wonderful attributes conferred upon these humble jelly-fishes,—attributes so inexplicable, that the most learned physiologists are at a loss to explain the manner in which they are exercised. The body of a Medusa, when submitted to chemical analysis, is found to consist almost entirely of sea-water: a specimen weighing four or five pounds, when the fluid part of its substance has been allowed to drain away, leaves a mere film of solid substance, the weight of which is not as many grains; and yet the water of the ocean, thus imprisoned in a cobweb, we find moulded into forms of exquisite beauty—endowed with sense and motion—able to seize, to vanquish, and to swallow prey—to glow with phosphorescent light, and lastly, to perpetuate their race by means as extraordinary as any other circumstances connected with their strange history.

In Mr. Patterson's very pleasing 'Introduction to Zoology,' we find the following practical observations upon this subject:—

"Our admiration for the various functions performed by the Acalephæ is much increased when we reflect upon the extremely small quantity of solid

matter which enters into their composition. On one occasion we took a dead specimen, and placing it on a piece of glass, exposed it to the sun. As the moisture evaporated, the different parts appeared as if confusedly painted on the glass; and when it was become perfectly dry, a touch removed the only vestiges of what had been so lately a graceful and animated being.

"We learned from an eminent naturalist (Professor E. Forbes), that a few years ago he had been delivering some zoological lectures in a seaport-town in Scotland, in the course of which he had alluded to some of the most remarkable points in the œconomy of the Acalephæ. After the lecture, a farmer who had been present came forward, and inquired if he had understood him correctly as having stated that the Medusæ contained so little of solid material, that they might be regarded as little else than a mass of animated sea-water? On being answered in the affirmative, he remarked that it would have saved him many a pound had he known that sooner, for he had been in the habit of employing his men and horses in carting away large quantities of jelly-fishes from the shore and using them as manure on his farm, and he now believed they could have been of little more real use than an equal weight of sea-water. Assuming that so much as a ton-weight of Medusæ, recently thrown upon the beach, had been carted away in one load, it will be found that the entire quantity of solid material would be only about four pounds avoirdupois weight, which, if compressed, the farmer might very easily have carried home in one of his coat-pockets."

Some of the Acalephæ are stated to attain a very

large size: Mr. Telfair saw a Medusa cast on shore in the Bombay territory in 1819, which must have weighed many tons. "I went to see it," says that gentleman, "when the gale had subsided, which was not for three days after its being cast upon the sand, but it had already become offensive, and I could not distinguish any shape. The sea had thrown it high above the reach of the tide, and I instructed the fishermen who lived in the immediate neighbourhood to watch its decay, that if any osseous or cartilaginous part remained it might be preserved; it rotted, however, entirely, and left no remains. It could not be less than *nine months* before it entirely disappeared, and travellers were obliged to change the direction of their road for nearly a quarter of a mile, to avoid the offensive and sickening stench which proceeded from it*."

Leaving, however, the contemplation of such monstrosities to gentlemen who are fortunate enough to encounter them, let us return to our native shores, and, as examples of the lovely objects at the disposal of our own sea-side visitors, select a few, which, although their lives are of ephemeral duration, may with a little care be made the inmates of the aquarium, and thus at least afford a passing opportunity of admiring their evanescent beauties.

The *Turris neglecta* (Pl. I. fig. 6) is an elegant little species, which, when in its native element, is brilliant as a bead of brightest coral. It is not uncommon in the Solent and around the Isle of Wight, and is thus described by Mrs. Davis, who had excellent opportu-

* Ed. New Phil. Journ. iv. p. 406.

nities of watching its movements during several weeks that she kept it in a glass of sea-water at Tenby, and subsequently at Bath, whither it was conveyed in a phial of the same, and lived three weeks after its arrival; we will therefore give the history of this "thing of light and life" in her own words. "One morning, while pouring some sea-water into the vessel containing my Actiniæ, I observed two small objects, which I took for the young of those animals, and as quickly as possible raised them in a spoon out of the basin and placed them in a tumbler of clean sea-water. They resembled tiny bell-glasses. Four transverse rays were perceptible on their sides, and a minute red body, with four white arms forming a cross, was suspended in the water. Around the edge of the bell or disc appeared a delicate white fringe, which was lengthened or shortened at the pleasure of the animal. The contraction was sometimes so great as to give the fringe the appearance of being knotted up to the edge of the bell or disc. It was highly interesting to watch their movements in the water as they ascended from the bottom, the bell or disc contracting and dilating alternately until the animal arrived near the surface. This motion was particularly conspicuous at the edge of the disc, and the fringe or tentacula lengthened as the animals rose towards the top; but when they descended again, the tentacula shrank up, sometimes to a great degree; after which the little creatures sank gradually, and without any visible effort. At the end of a fortnight one of my pets turned itself inside outwards, and remained in this state for some time, when it died, and left only

a few flocculent particles at the bottom of the vessel. The other lived more than two months longer, and even bore a voyage to Bath in a closed phial of sea-water, where it remained active and vigorous during the space of three weeks, when it likewise died, and disappeared like the former, but without the previous eversion."

The *Stomobrachium octocostatum*, another elegant form of these lovely animals, affords, when in confinement, a spectacle which is truly admirable, and has elicited a graphic notice from the pen of the Rev. David Landsborough, in his delightful volume on the Island of Arran. The Stomobrachium (Pl. I. figs. 8 & 9) presents in the water the appearance of a hazel-nut of a yellowish-brown colour; when caught however, and transferred to a glass filled with clear sea-water, it will be found that the brown-coloured melon-shaped mass by no means presents the true outline of the animal, but forms merely the centre of a gelatinous disc, which, though scarcely visible, constitutes a most efficient instrument of locomotion. Such, indeed, are the contractile powers of this transparent disc, that its sides nearly close at every stroke behind the opaque centre, like the legs of a vigorous swimmer, causing it at each effort to shoot briskly along as it rolls about backward, forward, or athwart. Even when placed in a tumbler of the purest water and examined with a magnifying glass, it is not easy to make out the true form of the animal, so exquisitely transparent is the bell-like disc of its pellucid body, which rises to a considerable heigh above the buff-coloured central portion, and is in shape as ele-

gantly moulded as the glass shades often placed over stuffed birds or artificial flowers. The finest crystal vase is clumsiness itself when compared with it; it is as translucent as the walls of a soap-bubble, and doubtless, when placed in the sunshine under favourable circumstances, equally iridescent. Nevertheless, delicate as its fabric is, the vigour of the little creature is very remarkable, and may be compared to the efforts of a strong swimmer, as it alternately contracts and expands its pellucid organization. The margin of its mouth is surrounded with a close fringe of brownish tentacula, which, by the aid of a lens, may be observed to become drawn in when the body contracts; but at every stroke made in swimming, they are protruded like forked lightning, or like feathered serpents darting and flashing forth till they are longer than the entire animal.

The *Sarsia gemmifera* (Pl. I. fig. 7) is a very small species of Medusa, scarcely a quarter of an inch in length, but an object of great interest on account of the remarkable manner in which it produces progeny from buds*, or by a process of gemmation from the walls of its peduncle, which, at certain seasons, presents the curious spectacle of young individuals in various stages of development, sprouting like so many mushrooms from its surface. These are not distributed in any regular order according to their degree of advancement, but at the same time there is an indistinct spiral arrangement to be observed, and the peduncle has a tendency to assume angular bendings at the points from whence the buds spring. In its

* Forbes, British Naked-eyed Medusæ.

earliest stage, one of these buds simply resembles a small wart, which, as it slowly increases in size, gradually assumes the shape and proportions of a young Medusa, and at length, when fully formed, drops off from its parent, ready to commence life on its own account.

Equally remarkable with the Medusa just described is the *Sarsia prolifera*, which differs from all the other members of that genus hitherto observed, in having at the base of each tentacle a supplementary bulb or a bunch of little tubercles, suspended like a bunch of grapes, all of which in time prove themselves to be young Sarsiæ, sprouting by gemmation from the bases of the tentacula (Pl. I. fig. 7). "Fancy an elephant," says Professor Forbes, "with a number of little elephants sprouting from his shoulders and legs; bunches of tusked monsters hanging epaulette-fashion from his flanks in every stage of advancement; here a young pachyderm almost shapeless, there one more advanced, but as yet all ears and eyes. On the right shoulder a youthful Chuny with head, trunk, and toes, but no legs, and a shapeless body: on the left an infant elephant better grown, and struggling to get away, but his tail not sufficiently organized as yet to permit of liberty and free action." The comparison seems grotesque and absurd, but it really expresses what we have been describing in these Sarsiæ. It is true that the latter are minute, but wonders are not the less wonderful for being packed in a small compass. "La force qui développe, l'intelligence qui spécifie et co-ordonne, l'amour qui unit et vivifie," are revealed as clearly in our little Sarsia

as in the mightiest monster of the ocean beneath whose shadow it may swim, invisible to the unarmed eye; and when we behold how strangely its perpetuity in that ocean is secured, we are tempted to exclaim—

> "Wonder it is to see
> How diversly I ove doth his pageaunts play,
> And shewes his powre in variable kinds!"

We must not, however, allow ourselves to be tempted too far; we have doubtless said enough to awaken the curiosity of the young naturalist, and must leave him to consult Nature herself for further illustrations of the variety of aspect under which these lovely creatures court his notice: their further history we reserve for another chapter.

CHAPTER VI.

"Formerly, the credulous were more ardent in quest of marvels than of the undisguised simplicity of truth. Nor did they seek those marvels which bounteous nature is alway prepared to disclose to them, for the purpose of mental elevation, or in adoration of the Omnipotent Architect. Rather than pursue knowledge for their own improvement by discovery, they descended to the baser objects of imposture and deception. Had they been exalted by the purity of intellectual contemplation to a due estimate of the religion of nature as revealed by the structure of the animated universe, unspeakable sources of admiration would have been opened before them."

HISTORY OF THE HYDRA TUBA.

THE naturalist whose diligent and careful researches lead him to examine with due attention the surfaces of stones, shells, or fuci found at low tide close to the water's edge in some sequestered pool, will, if good luck attends him, sometimes find adhering to them in considerable numbers, creatures resembling those delineated Pl. I. fig. 5, *a*, and having found them, let him lose no time in adding an acquisition so valuable to the best of his aquarian treasures. This is the *Hydra tuba*, whose romantic history (one of the most important zoological discoveries of modern times) we are now about to lay before the reader.

The mouth, which is situated in the centre of the circle of tentacula, when the animal is not disturbed,

is protruded in the shape of a four-sided tube, the orifice of which the creature keeps continually moving from side to side, as though in search of nourishment; but on touching the little animal, this mouth, or proboscis as we might almost call it, is at once retracted; the oral aperture, moreover, is capable of enormous dilatation, opening when the animal is about to swallow food, until it equals the capacity of the stomach itself.

The shape of the *Hydra tuba*, as represented in the figure referred to, resembles a hollow cone scarcely five lines in length, attached by its apex to some foreign body, with thirty or more very extensile, flexible, slender tentacula descending from the opposite margin collectively, forming a beautiful silk-like pencil waving amidst the water. The natural colour of the animal is universally dingy-white, or sometimes faintly orange, perhaps according to the season, or the quality of the food upon which it lives.

The tentacles, which exactly resemble so many filaments of spun glass, are, when fully extended, considerably longer than the body of the animal, and are moveable in all directions; they are likewise exceedingly sensitive, and, if rudely touched, at once join together into a bundle and shrink up into a very small compass; but they are never entirely retracted into the interior of the body.

The body of the *Hydra tuba* is a simple gelatinous bag, so irritable and contractile, that, when alarmed, the creature shrinks to half its original size; and yet at the same time so dilatable, that the animal swallows prey apparently much larger than itself. Its move-

ments in general are remarkably slow, and its appearance anything but indicative of energy or activity.

Nevertheless, fixed and apathetic as these creatures seem,—helpless and inactive as they might be supposed, few denizens of the aquarium will be found more voracious, or better able to satisfy their craving appetites. Who would believe that that transparent bag, hanging listlessly and lazily in the water as

> "The fat weed that roots itself at ease
> On Lethe's wharf,"

is a destroyer more redoubtable than even the fabled Hydra after which it takes its name? Who would dream, that those long silken threads which wave so prettily around its mouth were instruments of death more terrible than all Medusa's snakes? The food of the Hydra is by no means limited, as we might naturally conjecture, to vegetable particles or microscopic infusoria; on the contrary, creatures the most active of their kind not unfrequently fall victims to its rapacity, and its powers of destruction seem only to be restricted by the smallness of its dimensions. Observe the specimen before us, with its tentacula all expanded—hundreds of active little beings swimming round it—tiny shrimps of various forms disporting themselves in the water, any one of which appears ten times a match for such a sluggish foe. The Hydra seems unconscious of their presence, and hardly deigns to sweep the water with its lazy arms to seek its breakfast; but now a passing shrimp has hit against one of the outstretched tentacles, and instantly arrested in its course, succumbs before the magic touch; the

filament contracts and coils around the scarcely-struggling wretch,—arm after arm involves it in repeated folds, and slowly it is dragged towards the Hydra's mouth, which gladly opens to receive the prey. The trout that takes the mimic fly is not more firmly held by the tenacious line,—the landing-net gapes not more widely for the captive fish,—until at length the fatal gate is passed, and the swallowed victim finds itself plunged in the insatiable stomach of its destroyer, where it is ultimately digested and dissolved.

Such is the voracity of the *Hydra tuba*, that its real shape is only to be witnessed while the creature is labouring under temporary abstinence from food; for such is the capacity of its stomach, and so completely will the creature gorge itself, that it assumes sometimes the appearance of a round ball, and indeed, from excessive distension, will sometimes drop from its point of adhesion and fall to the bottom of the vessel. Neither is it at all nice in the selection of its food; it preys readily and greedily on most animal substances, and the quantities it devours seem altogether disproportioned to its dimensions.

When sated, the Hydra remains motionless, with the tentacula closely contracted. Judging by the long-continued appearance of coloured food through the skin, digestion is probably slow. The senses, if such exist, excepting that of touch, are certainly most obtuse. Hunger merely induces the extension of the tentacula, but there is no evidence that the presence of prey is discovered otherwise than by actual contact. No searching activity of the tentacula

is shown even when food is within their reach; no perceptions regarding it are betrayed, unless the action of the proboscis above alluded to can be regarded as of this character. However, when prey is seized, the animal is capable of raising large portions to its mouth, and its pendent position is clearly the natural one, affording the greatest scope for the play of its flexible tentacula.

This is an animal very impatient of the effects of light. While all the organs are finely displayed in comparative obscurity, they contract quickly on removal to the light, and always as if to avoid some painful impression.

The power of adhesion is probably spontaneous, as with the freshwater Hydra and the Actiniæ of the seas; but the *Hydra tuba* commonly remains stationary where it has taken a position. If affixed at first to the bottom of a vessel, it remains permanently there. If it drops from its place when attached to the side, or should the water be repeatedly agitated while either adults or young are loose, they seldom adhere afterwards, nor does the animal fix itself readily at any time.

A locomotive faculty, though rarely exercised, and only in the lowest degree, is undoubtedly enjoyed by these creatures. The adult is never seen in the act of progression, but the young Hydra withdraws itself from the parent, and in the event of successive generations, all the individuals constitute a colony around its original founder. Thus the perceptive and active faculties of these creatures are exceedingly obtuse, imperfect, and limited, farther than belongs to seizing

and ravenously devouring whatever prey they can master.

The special habitation of the Trumpet-Hydra seems to be the inner surface, and especially the upper cavity of empty oyster- and other bivalve shells. It diffuses itself anywhere, however, provided the position be favourable; but certainly best when pendent and under shelter. Notwithstanding this, it will be seen, as we proceed, that the position of the original founder of the colony must be accidental times out of number, and that the dispersion of the progeny is dependent on a great variety of circumstances.

A still more remarkable phenomenon in the history of these wonderful beings remains to be considered. It may be stated, as a general law of nature, that animals only become capable of producing offspring when they have arrived at a state of maturity: the caterpillar is not permitted to lay eggs until it has attained the form of the perfect Butterfly; the tadpole only acquires the power of reproducing its kind when it has gained the limbs and stature of the adult Frog: in short, it has hitherto been looked upon as an established axiom, that no larva or immature creature can be prolific. Now, as the reader will perceive further on, the *Hydra tuba* is not an adult animal, but only in a preparatory or larval condition, and yet, strange to say, it is enabled to furnish progeny and multiply its race to an extent that seems quite indefinite.

On watching closely one of these remarkable beings while in a well-fed and vigorous condition, the aquariist will not fail to observe, that at times little buds,

for such they may be called, sprout from the transparent walls of its gelatinous body, which at first have the appearance of simple warts or prominences, but which, in the course of a few hours, reveal themselves to be young Hydræ growing from the sides of the parent animal (Pl. I. fig. 4, *g*); a cavity soon appears in their transparent substance,—tentacles are seen like slender filaments to issue from the neighbourhood of the mouth, which, as they elongate, rapidly begin to fish for food in the surrounding water, and the new animal appears in all respects as perfect as the original being from which it sprung;—nay, sometimes two or three young Hydræ may be seen to sprout at once from the same parent, which in their turn give birth to others by a similar proceeding. After the development of the bud has been apparently completed, the parent and progeny are for two or three days adherent to each other, but at length they separate and become quite independent individuals.

It will easily be understood how, by a repetition of this process, numerous colonies may be developed in the course of a few months from a single individual, and accordingly we might suppose that none of Nature's products would be more common than the Trumpet-polyp; still it is not so. In fact, it is of very rare occurrence except under circumstances extremely favourable to its development.

There is still another way in which these Hydræ may be multiplied, which is even more plant-like than the last. We all know that many vegetables are capable of propagation by means of what the gardeners call "suckers" and "runners;" offshoots, which,

straying to a distance from the parent plant, again take root, and thus progressively spread far and wide, sending up other stems and giving birth to numerous progeny. The Hydra we are now contemplating is sometimes propagated in a manner precisely similar, —long filaments derived from some point of its substance spread themselves upon the stone or shell whereon the animal is fixed, like creeping stems, from which at intervals young Hydræ sprout, until a numerous colony thus emanating from a single individual rewards the patience of the naturalist.

The Hydræ can endure long-protracted abstinence, under which their size gradually diminishes; but they may be speedily restored again by plentiful sustenance, and will survive during years. They are likewise very tenacious of life, and are endowed with extraordinary regenerative faculties enabling them to survive the severest wounds and lacerations, and to reproduce mutilated parts.

CHAPTER VII.

HOW THE MEDUSA PRODUCES A HYDRA TUBA.

We are all of us in the habit of regarding it as a law of nature, that the offspring of any animal shall resemble the parent that gave it birth. We are not now speaking, gentle reader, of the never-to-be-doubted resemblance which every gossip finds between baby and its mama, until, as is always the case, it is proved to have papa's eyes, and papa's nose, and papa's mouth,—but of the more general similitude whereby the kitten is recognized as the young of the cat—the foal, of the mare—the calf, of the cow; in all of which instances the paternity of the species is clear and undeniable; and yet some of us may perhaps be startled to learn that nothing can be more erroneous than such a supposition. When Shakspeare tells us that all the world is a stage, on which Man himself plays many parts, his acts being seven ages, the immortal bard did not go far enough,—he might have said, that all the world is a stage, on which every animal in its time performs many parts, and that under forms so different, under disguises so dissimilar, that it is not too much to say, that every animal has to be in succession several other animals before it arrives at that condition in which the zoologist is pleased to recognize it as being itself. So

universal, indeed, is this metamorphosis that, we might almost be tempted to hold doctrine with Pythagoras, and think all creatures in a state of transmigration: from Man himself, Creation's lord, down to the humblest zoophyte in yonder tank, changes as wonderful as those we meet with in the insect world are witnessed by the naturalist at every step; and perhaps few more interesting subjects of study can offer themselves than the phenomena connected with these almost miraculous transmutations.

Among all the puzzles in this puzzling world, none have presented greater difficulties than the natural history of the MEDUSÆ. At certain seasons they present themselves upon our coasts in countless multitudes, only to disappear again in a manner equally mysterious and incomprehensible. In the year 1846, for example, the fishermen were embarrassed in casting their nets and sinking their lines from the multitudes of these jelly-fishes absolutely thickening the sea, and yet in a short time they all vanished, without any one being able to say either from whence they came or whither they went: in short, it may well be said of these lovely creatures, they are

"Indeed a beauty and a mystery."

Equally unintelligible and inexplicable was their mode of propagation: that they are amazingly prolific there could be no reasonable doubt, seeing the immense numbers of eggs with which they seem at times to be loaded, and which, tinted with various brilliant hues—purple and red, yellow and brown,—are seen arranged in broad festoons appended to their

floating bodies; still it was evident, from all observations made in relation to this part of their œconomy, that the progeny derived from these eggs were anything but like Medusæ, and it has only been by researches of a very recent date that satisfactory information relative to their growth and development has been obtained by competent observers, among whom we select Sir John Dalyell as the exponent of this portion of their history.

Selecting a specimen of *Medusa chrysaora* (Pl. I. fig. 4) eight inches in diameter, says Sir John Dalyell, I lodged it in a clear and capacious glass jar on the 24th of August. Herein the umbrella continued to collapse and to reach the surface by impulse on the water, as these animals do naturally in the sea. On gaining this position, the Medusa remained still and motionless, as if to be carried along by the flow or the ebbing of the tide. Nevertheless, although the specimen seemed sufficiently vigorous, it could be kept only a few days from decay. There seems a natural delicacy incident to the whole tribe in confinement; nor have I been able to preserve any adult individual above a month in activity.

On the 25th of August, this Medusa being removed from its vessel, a quantity of brownish matter, like dust, remained at the bottom. Subjected to the microscope it proved to consist of a multitude of animated creatures in quick and varied motion, but to the naked eye they were hardly perceptible — the merest specks, infinitely minute; nor by an ordinary lens could their proportions be discovered.

Higher powers, next resorted to, showed them to

be white, opake, and fleshy, tending to an elliptical form, though very mutable—one extremity generally broader than the other, with which each individual made its way amongst the multitude of its fellows. All were crawling about the bottom of the glass with a quick, smooth, lively motion. The body seemed consistent and soft, evidently yielding to pressure, as it forced its way through the crowd. No cilia or other external organs could be detected, for perhaps the magnifying powers were insufficient*. On the whole, the animals evidently closely resembled the *Planulæ*, hereafter to be described as the offspring of many races of Polyps, such as the reader will find represented in Pl. II. fig. 1, *e*.

After the lapse of other forty hours these little creatures began to appear of twofold composition, now consisting of a lighter margin surrounding a darker interior portion of corresponding form (Pl. I. fig. 4, *b*) —previously the whole had a uniform homogeneous aspect. Their shape had also become considerably modified; but whatever the outline of the exterior, that of the interior exactly corresponded.

In forty-eight hours, namely on August the 27th, the appearance of spots of scum at the surface of the water announced the progress of certain alterations below.

On applying the microscope, these spots were plainly discovered to consist of the *Planulæ* in a state of advancing metamorphosis. All remained still and floating. Some of the least-altered approached a

* The cilia, with the aid of a good microscope, are distinctly visible.

shuttle-shape, with an orifice in the centre; the ends of the shuttle were more prolonged in others, and several showed obvious indications of four incipient arms in unequal progress around a central orifice (Pl. I. fig. 4, *c*).

On the following day, August 28th, a remarkable change had ensued. The metamorphosis was rapidly advancing, for the elongated arms promised to be of a peculiar tentacular texture (Pl. I. fig. 4, *d*).

In three days longer this tentacular appearance was amply realized—the extent of the arms equalled some diameters of the body, the two from the ends of the shuttle remaining always more prolonged than the others.

All this was an extraordinary exhibition in the offspring of such parents that so lately issued in the form of almost invisible dust from compact, massy, ponderous animals, alike remote from their progeny in habits, in form, and in substance. But Nature had an important purpose to fulfil: the apparently rude commencement had to be carried through by wonderful expedients to symmetrical perfection in the end. In eleven or twelve days after the simple active atom, the Planula, had been discharged from the unwieldy Medusa, it was converted into a stationary *Hydra** ! (Pl. I. fig. 4, *e*, *f*).

* Unless in very favourable positions, it is by no means easy to follow the history of such minute specks as those of which we treat. The most convenient method of observation is when they are affixed to watch-glasses. The progeny of the Medusæ while yet Planulæ should be transferred to a flat vessel some inches in diameter, filled to any height with water. One or more

This new animal was provided with a complement of eight arms, yet so immature as to be of unequal dimensions. Different groups under metamorphosis showed the utmost irregularity in respect to evolution, both in their shape and proportions; nor was it until thirteen days later, or three weeks after their birth, that any appeared with eight regular tentacula.

Arrived at this point, the further development of the nascent polyp is easily and satisfactorily traceable —the arms gradually become more numerous and attenuated—the body more elongated and conical—the stomachal cavity in the interior distinctly formed, and the Hydra, now permanently fixed to some foreign object, begins to fish for prey, and exercise all the rapacity of its kind, until at length budding progeny begin to sprout from its sides (Pl. I. fig. 4, *g*), and it becomes the founder of a colony of kindred creatures, after the manner described in the last chapter.

Thus was a most perplexing problem solved—the *Hydra tuba* proved to have sprung from a *Medusa*.

watch-glasses may be then inverted over the Planulæ, and the whole allowed to remain perfectly quiet for some days.

Meantime the Planulæ rising from the bottom, in the course of metamorphosis, are intercepted from the surface of the water by the watch-glass, to which they will adhere. This will sometimes happen in two days. After remaining there two or three days longer, the watch-glasses should be removed to another vessel of water and kept in an inclined position, the concavity where the Planulæ adhere being downwards. In the course of about eight days many young Hydræ will be seen, pendent by the prolonged apex. It is preferable to have only a few thus adherent, as a number confuses the view. The subjects secured in this manner are afterwards easily accessible.

CHAPTER VIII.

"Nothing of him that doth fade,
But doth suffer a sea-change
Into something new and strange."

HOW THE HYDRÆ TUBÆ PRODUCE MEDUSÆ.

We have hitherto viewed the *Hydra tuba* as an animal apparently perfect in itself and sustaining an independent life. A creature which survives for years, which transmits its form, together with all its peculiarities, to its immediate progeny and to remote descendants, seems certainly, at first sight, entitled to a distinct position in the zoological series; but we have still to look farther, to dive deeper into the strange history of this wonderful production, before pronouncing as to its real nature.

At certain seasons of the year, that is, as far as we know at present, during the months of February and March, the *Hydra tuba*, if well-fed and vigorous, begins to exhibit an extraordinary elongation of its body, and gradually increases in size, until it is evident that some great change is in preparation, and in a short time numerous transverse folds begin to make their appearance at equal distances, one below the other, partitioning off the body into numerous rings or segments (Pl. I. fig. 5, *d*).

In the course of a short time the segments thus formed become surrounded with marginal rays dichotomously divided at their extremities. These arms or rays are free, all having their apices turned in the same direction, and disposed with such regularity, that the once polyp-like body seems to be furnished with eight longitudinal ribs (Pl. I. fig. 5,*e*), and now evidently consists of a series of discs placed one upon the other, like a pile of soup-plates or saucers; but as those nearest the top of the pile grow more rapidly than the rest, the creature ultimately assumes a conical shape, somewhat resembling a champagne-glass (Pl. I. fig. 5,*f*), or, as a lady observes of some specimens now before us, "they look exactly like the tassels of our dimity curtains." In this condition the *Hydra tuba* is the far-famed *Strobila*, whose remarkable history, first discovered and described by M. Sars in the year 1829, formed an epoch in zoological science.

And here comes the most wonderful part of the proceeding: the uppermost disc of the Strobila, now nearly mature, begins to exhibit very distinctly the form of a Medusa, and after sundry tugs and pulls, as though impatient of restraint, breaks loose from the top of the pile (Pl. I. fig. 5,*h*), and escaping into the surrounding water, swims away, presenting all the characters and attributes of a free Acaleph, and in this condition assumes an independent existence under the appearance represented in the figure (Pl. I. fig. 5,*g*).

A group of twelve individuals, just on the point of separation, measured about one-third of an inch in length, and when examined by the microscope,

movements of contraction and expansion, precisely like those exhibited by the free Acalephæ, were distinctly visible; in the course of about a quarter of an hour the upper individual of the group detached itself from the rest and swam away, an example which was immediately followed by the rest in rapid succession; so that in the course of an hour from the commencement of this strange breaking-up, the whole colony had separated, and its various members were seen swimming about in the watch-glass under the form of minute Medusæ.

The colour of the little Medusæ, when first liberated from the *Strobila*, is a delicate red, or rather they are perfectly transparent, but dotted with minute red points, although occasionally they are as pellucid as crystal. They swim about with great vivacity, alternately contracting and expanding the little rays surrounding their disc; but whether their course through the water be in a vertical or horizontal direction, the convex surface of their body is always foremost. Sometimes they will sink motionless to the bottom of the water, as though to rest themselves, resuming after a while their merry evolutions with increased energy. If one of them is touched while swimming, it immediately folds up its rays over its mouth and sinks, but soon recovers itself, and, if left undisturbed, resumes its evolutions in the water.

Although these little creatures are more tenacious of life than the majority of the larger Acalephs, it has been found impossible to keep them for any length of time in confinement; for about eight or ten days they continue to swim about with undiminished

activity, but at the end of that time they generally begin to flag, and rarely survive more than a fortnight, at which time their movements become very slow and feeble, and then they vanish, leaving behind them no perceptible trace.

Long ago, says Sir John Dalyell, I had remarked colonies of minute transparent animals swimming in vessels of sea-water during the months of February, March, and April. Their general aspect very much resembled a flock of birds in distant flight, as represented by landscape painters (Pl. I. fig. 5, *b*). After being transferred to vessels free of other subjects, they continued several days in activity and then disappeared. I could not account either for their origin or their transience. They occurred only at rare intervals, and always identically under the same form.

More accurate inspection showed the alliance of such creatures to that comprehensive genus the *Medusa*, both in configuration and habits. But the date of their appearance did not correspond with the wonted periodical ascent or arrival of that tribe to the surface of our seas during the summer months—indeed they were met with as early as the 6th of February.

The species of Medusa to which these little beings belonged, is that long ago denominated by Baster *Medusa minutissima*, and being, in fact, among the more minute, it may be rather considered a microscopic object than otherwise. Its expansion is between one and two lines, nor did it present any sensible growth during the longest period (sixty days) of its survivance.

This creature's body (Pl. I. fig. 5, *g*) consists of a

central disc with from four to twelve horizontal, flattened, *cloven* arms or lobes. An organ like an obtuse-sided cluster-column projects from the middle of the *under* surface, corresponding to the site of the proboscis in other Medusæ. Each lobe is cleft half-way down. A cone in the centre at the bottom of the cleft is surmounted by a black speck, which a powerful magnifier shows to consist of a number of smaller specks on a lighter ground.

For the most part, the existence of the *cloven Medusa* is very transitory. It appears unexpectedly, and in a few days it decays or vanishes, though occasionally obtained directly from the sea. Sir J. Dalyell was led to remark that they had been chiefly observed in vessels containing the *Hydra tuba*, and that when removed they were frequently replaced by others; nevertheless, no visible spawn, fragments, or other elements to which their origin could reasonably be ascribed, were ever distinguishable. He observed, moreover, that they occur in the greatest abundance in March, their appearance dating from the beginning of February, during forty or fifty days; and that they are not to be seen from that season throughout the rest of the year.

Eight of these Medusæ being observed on February 6th, in a vessel containing many specimens of the Hydra which had been long under observation, they were removed a day or two subsequently, as they were conjectured to have been introduced in a replenishment of sea-water; but they were soon succeeded by others appearing in the same vessel on the 14th and 15th. Meantime Sir John had remarked a con-

vulsive motion among the tentacula of a Hydra on the evening of the 14th, apparently from a Medusa having been seized by its arms. The like occurred next morning, when another Medusa was apparently liberated from like thraldom.

Similar convulsive movements agitating the same Hydra during the 16th, it was brought under close inspection, for being unable to discover the like spasmodic demonstrations among its companions, at least 100 in number, it seemed surprising, that amidst such a host of enemies, mercilessly devouring whatever they could master, the Medusa should live with impunity involved by the very organs of capture.

On dislodging the subject of this observation, apparently a Hydra of medium size, with scissors, and transferring it to a watch-glass, nothing but the wonted convulsion which proceeded from the clasping of the arms of a Medusa upon the disc or extremity of the Hydra was seen on the morning of the 17th. However, several little Medusæ were swimming at large next day; the size of the Hydra had diminished, it was visibly indented with deep corrugations, and when closely examined, proved to be wholly composed of Medusæ, in various stages of development. The arms at the summit belonged to the animal which was most mature. Many more in the lower part of the series soon became active, and beneath them still more were perceptible, as yet in a state of absolute quiescence and indefinite in form (Pl. I. fig. 5, *h*). Seven advancing Medusæ in all might be enumerated in the mass in the course of this day, the 18th of February.

...y, the 19th, at noon, another Medusa, ne-...y the highest in the series, was observed to have quitted the group, and another swam at large in the evening; further, a third having escaped on the following evening, all these three were free.

Next day, that is on February 21, after vehement clasping at the summit of the mass, a fourth was liberated, while new struggles to escape appeared in the place it had left, and on the morning of the 22nd, six in all were swimming in the water. A seventh, freed on the 23rd, swam with the rest, and these seven, pursuing their course or suspended *in equilibrio*, resembled as many minute stars.

At this juncture there was reason to conjecture that the smooth slice or basis of the colony adhering to the watch-glass was something different from the animals that were successively quitting their position above it, and that it was in reality either an entire Hydra or a portion of one; nor could any doubt upon the subject possibly remain, when on the 25th of March, being entirely free of the Medusæ, its long silky-looking tentacula were seen waving in the water. Further, its nature was subsequently unequivocally demonstrated by the germination of a young Hydra from its body a month later, and in May another descendant of one or other of the two had established itself independently.

From the above observations, then, and from numerous others of a similar character, certain facts are established which admit of no dispute. Such are—1st, the existence of a vigorous Hydra attached to a solid substance, with long, flowing, silky tentacula;

2nd, an alteration in the figure of its body from the formation of a roll of embryonic Medusæ on the disc; 3rd, the gradual maturation of each Medusa, and its liberation from the roll; 4th, the disappearance of the original tentacula of the Hydra; 5th, the emerging of a new circle of tentacula from a smooth fleshy bulb sustaining the embryonic roll; and lastly, the evolution of this fleshy bulb as a perfect Hydra, which becomes the parent of other Hydræ by gemmation, and remains permanent as an independent animal.

All the Medusæ in the embryonic roll are separate and distinct beings; each is in close application to that which is next below if itself be uppermost, or lies between two if intermediate. The proboscis is outermost if the individual be uppermost in the pile; thus all lie in the same direction, the proboscis outermost, as the Medusa escapes from the next left behind. When the last remains adherent to the fleshy bulb, its proboscis projects outwards also. Thus the under-surface of the embryo is always outwards while it forms a portion of the roll, an arrangement which evidently shows that the maturation of the embryos and their liberation into active life must be successive.

CHAPTER IX.

"O! mourn not, that in nature, transitory
Are all her fairest and her loveliest things."

CYDIPPE POMIFORMIS, THE APPLE-SHAPED BEROË.

Amongst all the elegant forms of the Medusæ none can compete with the *Beroë* (*Cydippe*) *pomiformis*, or emulate the wonderful machinery whereby it frolics in the glassy water. In the bright sunshine, on the level sand, just where the gentle ripples "kiss the shore, then sleep in silence," the observant eye may sometimes see a pearl—for such it looks to be—worthy of being a pendent to the one dissolved by Cleopatra,—but so frail, so delicate, so evanescent, that it must be taken up with tenderest care by those who would survey its beauties, and at once transferred into a vessel filled with its own element. Its body is then seen to be a little globe of clearest crystal (Pl. I. fig. 10) tinted with the hues of Iris, and, moreover, fringed from pole to pole with eight transparent bands of active cilia rapidly at work, by the aid of which it glides along, advancing like a meteor through the water.

It is, however, when the Beroës* have just been taken from the sea that they exhibit in the highest perfection their locomotive powers, and display in the

* Patterson.

bright sunshine the splendid iridescence of colouring caused by the action of their cilia to the greatest advantage. As they wheel onwards, rising and falling at pleasure, and creating in their course the glory by which they are encircled, they seem indeed

> . . . . . "gay creatures of the element
> That in the colours of the rainbow live."

The variety of their evolutions constitutes one of their principal charms. Sometimes they will ascend from the bottom of the jar to the surface of the water with a slow and regular movement, resembling that of a balloon, and descend at the same rate of progression. Again, they will rise more rapidly, and turning their mouth downwards descend with equal rapidity. At other times, without rising or falling, they will revolve on the transverse axis of their body—then, abandoning all these modes of progression, they will revolve on their longitudinal axis, holding the body vertical, and in this position twirl round and round the glass like graceful waltzers. When the movements of the animal are thus varied, how great must be the variety of motion in the cilia by which the body is propelled! Never for more than a second or two do the cilia cease to vibrate. Even then it is not a total suspension, but a slower and alternant action that is exhibited; the cilia on one or two contiguous bands remain stationary, while the adjacent ones on either side are in motion—then those which have been still begin to play, and those that were previously moving remain still: no regular succession of procedure is observable, but some portion of the

bands of cilia are kept constantly in action, all seeming to perform their duties quite irrespective of the rest.

The tentacula of these beautiful animals are, next to their cilia, the most interesting portions of their structure. These organs are not always apparent, but remain enclosed in the creature's body. They are seldom displayed immediately after the Beroës have been captured, nor when the glass vessel in which they are kept is too much crowded. When, however, not more than five or six are placed together, the tentacula may be seen developed to their fullest extent, frequently extending above six times the length of the body of the animal. The tentacula are often projected from their tubes to their full extent by one impulse, and the slow uncoiling of the slender serpentine filaments from their margin is then very beautiful. Indeed, it is scarcely possible to convey by any description an idea of the elegance and diversity of their forms. They seem endowed with exquisite sensibility, which, however, is not always equally delicate. At times, the slightest touch will cause a tentaculum to be drawn back into its sheath with a sudden jerk; at other times it is apparently unfelt. The Beroës never seem to be poised or supported in the water by the assistance of these remarkable organs; but sometimes, when they are extended to the bottom of the vessel, they seem to act as suckers, and to form fixed points whence the animal rises and falls at pleasure, appearing as if moored by these delicate and novel cables.

"Like a planet around its sun, or more exactly," says Agassiz, "like the comet with its magic tail, the

little *Cydippe* moves in its element as those larger bodies revolve in space; but unlike them, and to our admiration, it moves freely in all directions, and nothing can be more attractive than to watch such a little living comet as it darts with its tail in undetermined ways and revolves upon itself—unfolding and bending its appendages with equal ease and elegance; at times allowing them to float for their whole length, at times shortening them in quick contractions, and causing them to disappear suddenly—then dropping them, as it were, from its surface, so that they seem to fall entirely away, till, lengthened to the utmost, they again follow the direction of the body to which they are attached, and with which the connexion that regulates their movements seems as mysterious as the changes are sudden and unexpected.

"At one moment the threads, when contracted, seem nodose; next, the spiral, elongating, assumes the appearance of a straight or waving line. But it is especially in the successive appearances of the lateral fringes arising from the main thread that the most extraordinary diversity is displayed. Not only are they stretched under all possible angles from the main stem, at times seeming perpendicular to it, or bent more or less in the same direction, and again, as if combed into one mass; but a moment afterwards every thread seems to be curled or waving—the main thread being straight or undulating; then the shorter threads will be stretched straight for some distance, and then suddenly bent at various angles upon themselves, perhaps repeating such zigzags several times; then they will become coiled up from

the tip, and remain hanging like pearls suspended by a delicate thread to the main stem; then, like a broken whip, become bent in an acute angle, with as stiff an appearance as if the whole were made up of wires; and, to complete the wonder, a part of the length of the main thread will assume one appearance, and another part another, and, moreover, pass from one into the other in the quickest possible succession. When expanded, these threads resemble rather a delicate fabric spun with the finest spider's thread; at times brought close together, combed in one direction without entangling; then becoming stretched apart, and preserving in this evolution the most perfect parallelism among themselves, and at no time and under no circumstances confusing the fringes of the two tentacula. They may cross each other, they may be apparently entangled throughout their length; but let the animal suddenly contract, and all these innumerable interwoven fringes unfold, shrink, and disappear, as if made of the most elastic India-rubber."

It appears, from the observations of Dr. Strethill Wright, that the surfaces of the tentacula of Cydippe are crowded with minute thread-cells or stinging organs, and must be regarded as instruments for the capture of prey. "I had frequent opportunities of seeing these animals take their prey by the aid of their tentacles, and was delighted with the address they displayed in using these seemingly unmanageable appendages. The food of Cydippe was easily ascertained, as the stomachs of many of the specimens taken were packed with minute crustacea. To

ascertain how the latter were captured, I threw one of them into a jar in which was a Cydippe which had evidently not dined that day. It was instantly caught by one of the tentacles. The Acaleph at once became very animated, and performed a series of somersaults until it had succeeded in hitching the tentacle which held its prey across the widely-gaping mouth as over a pulley. The tentacle was then contracted by successive jerks until the morsel was hauled up and dropped into the stomach. This experiment was frequently repeated, with precisely the same results, by myself and friends with the same and other specimens of Cydippe."

The Beroës, notwithstanding the excessive delicacy and translucency of their structure, have voracious appetites, and will eagerly devour minute crustacea measuring from a line to a line and a half in length; the bright colouring of the prey so swallowed contrasting most conspicuously with the crystalline transparency of the body in which they are enclosed.

If, however, the Beroës thus live upon the small crustacea, they in turn furnish a supply of food to Medusæ more powerful than themselves. "On the 12th of May," writes Mr. Patterson, "I took a small Medusa of the genus *Callirhoë*, and placed in the glass vessel with it a Beroë which had been taken at the same time. While the latter was swimming round the glass with that lively and graceful movement for which it is so remarkable, it came in contact with the filiform tentacula attached to the arms of its companion. The arms instantly closed, and the Beroë was a prisoner. I endeavoured to separate them, and

for this purpose moved them about by pushing them with a camel-hair pencil, but without effect In about half an hour afterwards, when I again observed them, they were asunder, the Beroë swimming about, and the cilia of its bands vibrating as briskly as usual. It had not, however, escaped uninjured from its captor. The Callirhoë had taken from the body of the Beroë 'a huge half-moon, a monstrous cantle out.' In fact, the portion thus removed occasioned a vacancy which extended transversely across three of the bands, and longitudinally for about its entire length. The being which had suffered this mutilation seemed, however, quite unconscious of its misfortune, moved about in every respect as before, and for four days seemed to possess all its powers in unimpaired activity."

To this instance of apparent insensibility to pain, may be added one illustrative of the extent to which the principle of vitality is diffused through every portion of the structure of these elegant Acalephs. On one occasion, two Beroës were taken after a storm, with some of the cilia abraded, and other parts of the body shattered and even torn. All the cilia, however, which remained attached to these mutilated parts retained their full activity. The most damaged of the two was then cut, with a pair of scissors, into several pieces, and each part continued to exhibit in its cilia the same undiminished rapidity of movement. One of these portions was again subdivided into parts so minute as to possess only one, or at most two cilia on each, yet no change in the ceaseless motion of these extraordinary organs took place. Thirty-three

hours after this minute subdivision several of them were vibrating as usual, and at the expiration of forty-two hours the two cilia belonging to one fragment showed undiminished activity.

The mode of reproduction in the Beroës has long been a subject of interesting inquiry, and on this point of their history Dr. Strethill Wright had the opportunity of making the following observations*. He found in Morecambe Bay, near Lancaster, one day in June, swarms of the *Cydippe pomiformis*. Every little creek and channel in the sand-banks was full of them, where a day or two before or afterwards not one was to be seen. On examining one of these animals confined in a jar of sea-water, a great number of transparent vesicles were observed in the lateral water-vascular canals. Some of these vesicles were floating freely in the circulating fluid, but the greater number were attached in pairs to the inner surface of the muscular bands, a pair between every two of the ciliary paddles. The constant motion of the paddles rendered it difficult to ascertain the true nature of these vesicles, but the next day a considerable number were seen floating freely in the jar, and were placed under the microscope. They consisted of a transparent and highly refractive vitellus, containing a germinal vesicle and germinal spot, and surrounded, at a considerable distance, by a thin envelope or shell. Several of these ova were placed in a small trough of sea-water and carefully watched for some days, but no further development occurred in them. In the meantime, the water containing the parent Cydippe

* Edin. Phil. Journ. 1856.

was examined every day with a single lens, and after a few days, minute bodies about the size of rape-seeds were detected swimming about amongst the eggs. These proved to be the hatched young of Cydippe. The rest of the ova were found in all stages of advance towards full development, as represented in Pl. I. fig. 10, *a*, *b*, *c*. Fig. 10, *a*, shows the newly extruded egg, with yolk and shell. In fig. 10, *b*, the yolk has become irregular in shape, granular and opake. In fig. 10, *c*, the embryo is elongated into an irregular cylinder, and is encircled by a wreath of long cilia, by which it is rapidly whirled round in the shell. In fig. 10, *d*, the ciliary wreath is broken up, and divided into four bundles—the upper part of the embryo has become transparent by the gradual absorption of the yolk, and the tentacles have appeared as simple granular threads, and as yet destitute of the lateral cirri which adorn those of the adult. In fig. 10, *e* (representing the newly-hatched Cydippe), the four bundles of cilia have extended themselves into short bands, and the tentacles have become greatly lengthened. At this point, unfortunately, Dr. Strethill Wright's observations were arrested, all the young Acalephs having died at this stage, which they attained in about five days; and he was not able to find other specimens either in the first or more advanced stages of development. Should a similar opportunity present itself to any of our aquarium-cultivating readers, we sincerely hope that more fortunate circumstances will enable them to complete a series of observations at once so interesting and novel.

PLATE II.

CHAPTER X.

"Thy very weeds are beautiful."

TUBULARIA INDIVISA. THE SIMPLE TUBULARIA, OR OATEN-PIPE CORALLINE.

THE *Tubularia indivisa* (Pl. II. fig. 1), one of the most elegant of our native zoophytes, might easily be mistaken by a superficial observer for a flourishing vegetable, which, although destitute of leaves and branches, exhibits, in the rich tints of its "animal flowers," a spectacle hardly to be surpassed by the gayest productions of the realms of Flora.

This beautiful polyp, although very generally to be obtained on most parts of the coast, is an inhabitant of deep water, dwelling at a depth of thirty or forty feet below the surface of the sea, and is therefore, under ordinary circumstances, only procurable by means of a dredge net; but when thus obtained, will amply repay the Aquariist for his exertions, and afford him an abundant supply of subjects for observation.

A bunch of Tubularia fresh from its native bed is indeed not unfrequently a perfect garden in itself, every stem being densely populated with other forms of zoophytes, growing in rich profusion from its surface, and affording a spectacle well calculated to im-

press us with an idea of the immense profusion of animal life that flourishes in the recesses of the ocean. The contemplation of such a scene under the microscope is overwhelming. A cubic inch of it contains enough of interesting materials to occupy the lifetime of the most laborious naturalist. Let us, however, confine our attention to the Tubularia itself, and endeavour to lay before our readers the principal features of its economy as a guide to their further researches. Its body consists of a yellow horny stem filled with mucilaginous pith, and is rooted below on some solid substance, while above, it is crowned by a living head, resembling a fine scarlet blossom with a double row of tentacula, and often exhibiting pendent clusters like grapes, embellished by various hues, wherein red and yellow predominate.

Though perfect as a single stem, this zoophyte seldom appears in a solitary state; two, three, fifty, or even a hundred and fifty stalks are sometimes crowded together; and in such a case, their heads, of diverse figures, shades, and dimensions, constitute a brilliant animated group, too rich in nature to be effectively portrayed by art. The stalks of a numerous colony are frequently intertwined towards the root, which runs as a mere prolongation of the stem on the subjacent substance, or descends over its sides in a tortuous form in strong adhesion, but always destitute of radicles, like those whereby vegetables are implanted in the earth.

The "head" or polyp is in all respects a true *Hydra*, and resembles exactly in its general structure the beings of that extraordinary race whose history

we have already laid before the reader. It consists of a central pouch or stomach, the orifice of which is surrounded with a double row of tentacula, varying in number from fifteen to thirty-five in each row, while interposed between these two rows of larger and of lesser feelers, and apparently originating from the external lower part of the polyp, are seen the *ovaria*, resembling minute protuberances at their first appearance, but forming pendent clusters on reaching maturity.

The tallest specimens sometimes rise as much as thirteen inches high, and the stalks are about a line in diameter where thickest, but the height and diameter, the general luxuriance and the fertility of the zoophyte, have no reciprocal dependence on each other.

The *Tubularia indivisa* is generally found on shells, entire or decayed, empty or tenanted, and sometimes, in the latter case, a brilliant group may be met with, carried along in its course by the crawling inhabitant. As few vegetate on stones, the calcareous matter of shells may possibly be more favourable to their evolution.

When the polyp or "head" of the Tubularia has attained complete maturity, the tentacula become much curved, their wonted regularity is impaired, and their extremities indicate approaching decay. The pendent ovarian clusters spread luxuriantly over them; the central pouch, as if its faculties were exhausted, is empty and contracted—the whole betrays a languishing and sickly aspect. Next, a point of intersection may be discovered amidst the ruddy pith near the summit of the stalk, and the flower-like polyp, separating at this

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point, soon falls off into the surrounding element, but not to perish immediately; demonstrations of life continue during many hours; nay, they are protracted for eight days or longer in vigorous specimens. Some analogy with the form of the simple Hydra may be now recognized in this separated portion; but the short stump under the head, which is drawn from the stalk by separation, and represents the body of the Hydra, has no power of adhering to foreign objects; nor are the feelers of that extensile nature, nor prehensile power, which characterize those of the Hydra proper.

Meantime the florid summit of the vacant stalk becomes pale and appears to be fading; a kind of cicatrix closes the wound. But after the lapse of a certain interval, it darkens again, and an internal bud is seen advancing, which speedily ascending, bursts the transparent skin and flourishes a new head, springing precisely from the same point whence its precursor had fallen, and of equally vivid hue.

Singular to be told, the regenerative faculty is not exhausted here; for after continuing to flourish during an indefinite period, this second head droops and dies, and is dissolved like its predecessor. Then it is replaced by a third, and the third by a successor. How often the like may be repeated, how many successive heads may be generated anew during the whole life of the zoophyte, cannot be readily ascertained.

Some remarkable facts attend this renewal of the head: the prolongation of the stem seems absolutely dependent upon it: having lost its head, the stem to all appearances remains unchanged, unless in the cir-

cumstance of the wound closing; but from the moment that the rising internal bud reaches the vacant extremity of its integument, the neck, or that portion sustaining this young Hydra, visibly lengthens until further prolongation is arrested by the separation and fall of the regenerated parts. The wound cicatrizes again. If the process of reproduction is repeated by another polyp rising within, to issue in its turn from the summit, a new prolongation ensues also, and so on with a third, fourth, or more. Thus are formed as many nodes or articulations of the stem. But the irregular duration of the successive Hydræ or heads produces an irregularity in the accessions to the length of the stalk. One shoot extending six or eight lines may be followed by another only two or three, and the prolongations seem scarcely sensible when the head flourishes merely to decay. Let it, however, be remembered, that the prolongation of the neck, which takes place at these intervals, is the sole mode of extension in the stem of the zoophyte.

The renovated shoot is at first flexible, especially towards the head, but in time greater rigidity ensues, and the colour fades. In full-grown and fertile specimens of Tubularia, several florid clusters, resembling minute bunches of grapes, with three, seven, twelve or more berries in each, weigh down the most luxuriant heads. These constitute the ovarium, composed of so many capsules or cysts, each, in an advanced stage, containing a single embryo. The greatest disparity of size and number prevails among the cysts and the clusters, nor are they of uniform figure. Each cluster is suspended by a hollow stalk from the lower part of

the polyp, and each cyst hangs by a pedicle from this stalk (Pl. II. fig. 1, *f*). The integument of the cyst is rather of a fleshy consistence, either opake, or so thin and transparent as to expose its contents; each contains a solitary embryo, which, on arriving at maturity, is expelled slowly and gradually as a minute white solid substance, from a dilateable orifice at the extremity.

Soon after expulsion an irregular zone or waving line may be recognized on the circumference of the embryo, which within a day denotes originating tentacula. In earlier stages the animal resembles a star with obtuse rays, or the spokes of a wheel. The centre is next prolonged in opposite directions, on the one side as extending tentacula, on the other as the neck or stalk of the Hydra. Meanwhile the circumferential tentacula exhibit enlarged extremities, by means of which the nascent animal, sustaining itself in a position the reverse of that which it will ultimately assume, can voluntarily change its place. The central portion forming the stomach next augments in size, the swelling extremities of the tentacula refine into points; the animal, still a simple Hydra endowed with locomotive faculties, next reverses its position and becomes permanently rooted on the plane supporting it, assuming the appearance and characteristics of a Tubularia (Pl. II. fig. 1, *g*).

Such is the issue of this remarkable process, and that sometimes within twenty-four hours after the expulsion of the embryo from the ovarian cyst. The clustering ovaria are generally confined to the largest heads, and for the most part March and April may be held to be the chief season of propagation, though, as

is the case in various other zoophytes, it is not absolutely excluded from any period of the year.

It appears from some experiments of Sir John Dalyell, that a greater number of polyps than are allotted by nature to a single individual may be obtained, almost at the pleasure of the observer, by making artificial sections or cuttings of the zoophyte, and in this way twenty-two Hydræ have been made to originate from three sections of a single stem: the phenomena attending this process are sufficiently remarkable to make a repetition of the experiment a matter of interest. A luxuriant head having fallen from a specimen, the stem, previously detached from its original site, was divided into three portions, the lowest two inches long, and each of those above it of the length of one inch. Nothing resulted from the highest segment, where growth might have been most expected; but in ten days a head burst from the lowest, where it might have been least expected, and in fourteen days another sprouted from the top of the middle section; and in this manner the Hydriform polyps may be artificially multiplied by a repetition of a similar mode of proceeding, apparently to an indefinite extent.

CHAPTER XI.

EUDENDRIUM RAMOSUM.

We heartily recommend such of our readers as may be desirous of obtaining the marine productions of our coasts in their full luxuriance and perfection, and, moreover, of procuring many rare and valuable specimens, which would otherwise be hard to meet with, to cultivate the good offices of the fishermen who may be employed in their vicinity. These men, who are busy with their nets at all seasons and in all weathers, will often be found of invaluable assistance, but, unfortunately, it too frequently happens that they are rather an unpersuadeable and unmanageable fraternity, having whims and fancies of their own, against which eloquence and argument are equally inefficacious. To try to convince them that it is worth their while to bring home anything not *Fish*, is to attempt to controvert one of their maxims of life; and to endeavour to cajole them into the belief that the refuse of their nets—which in the North they designate by the general term of "pushin" or "pussom" (*poison*)—can be of any value, is to stir up in their minds serious doubts as to your own sanity.

We remember upon one occasion, whilst naturalizing upon the Scotch coast, taking no small pains to

illustrate to a group of these worthies, by exhibiting to them specimens picked up upon the beach, the nature of the objects we wanted them to procure, and flattered ourselves, after bestowing upon them, as we thought, a very interesting lecture, that we had succeeded. A new-comer, however, who joined the group, happening to inquire, "What the gentleman was wanting?" we were somewhat disconcerted on seeing one of the bystanders significantly touch his forehead and inform him in an undertone, that "the gentleman was daft." Still we must reiterate our advice to cultivate the good offices of the fishermen, many of whom will be found by no means so unpracticable as our Scotch friends, and by their assistance the reader may perchance be indulged with an opportunity of studying the history of the EUDENDRIUM RAMOSUM, one of the most interesting zoophytes met with in our seas.

The Eudendrium (Pl. II. fig. 2), as its name imports (*εὖ beautiful, δένδρον a tree*), has much more the appearance of being a vegetable than an animal production, at all events until, when examined in its native element, it is permitted to unfold its beauties to the day, and thus reveal its proper character.

Sometimes it resembles an aged tree, blighted amidst the war of elements or withered by the deep corrosions of time; sometimes it resembles a vigorous flowering shrub in miniature, rising with a dark brown stem and diverging into numerous boughs, branches and twigs, all terminating in so many Hydra-like polyps, wherein red and yellow intermixed afford a fine contrast to the whole. The glowing colours of

the one, and the venerable aspect of the other, the delicate polyps often laden with prolific fruit, and the numerous ramifications, all highly picturesque, are well calculated to attract our admiration and excite the interest of the observer.

A remarkably fine specimen is described by Sir J. Dalyell, which was obtained from among the rocks of a cavity in the bottom of the Frith of Forth, at about 150 feet from the surface; it had vegetated in such a direction that it was detached quite entire.

Being transferred to a capacious vessel of sea-water, this beautiful zoophyte was found to rise seven inches and a half in height. Its stem, measuring about nine lines in diameter near the root, soon subdivided into several massy boughs, besides many lesser branches; numberless twigs, terminated by thousands of minute Hydræ of the palest carnation, clothed the extremities, which were ten inches apart. The root consisted of multitudes of moss-like fibres, extending over a circle two inches in diameter. The stem and the higher rigid portions consisted of irregular bundles of tubes, while the absolute extremities bearing the Hydræ resolved themselves into single tubes, each with its appropriate animal.

Many parasites invested this splendid specimen. Masses of the pure white and deep orange *Alcyonium digitatum*, or *Lobularia*, hung from the boughs; *Sertulariæ*, Sponges and Algæ were profusely interspersed, all proving by their obviously successive generations, that the Eudendrium on which they had their growth had attained to a considerable age.

The "heads" or Hydræ of the Eudendrium are de-

ciduous, like the Hydræ of Tubularia, though perhaps for another purpose, because it is not in them that in this case the elements of posterity are met with. Of eighty vigorous Hydræ which embellished the specimen represented in the Plate when first withdrawn from the sea, only forty subsisted on the second day, thirty on the third, twelve on the sixth, four on the seventh, two on the eighth, and on the tenth there were none—the whole had fallen off.

The head survives its fall for a short time, or more generally, it wastes away suddenly without falling. Likewise its decomposition is rapid. Though many may have wasted or fallen in the course of the night, none are to be discovered at the bottom of the vessel next morning.

A nascent bud, however, soon rises within the hollow tube to replace the fallen polyps, precisely in the same manner as in *Tubularia indivisa.* A beautiful group of six or seven specimens, chiefly about 2½ inches high, bore numerous Hydræ on the 12th of February. All had fallen in three days. But after twelve days more, many new heads were flourishing, and many buds in different stages appeared amongst them. The distribution, proportionate increment and perfection of the renovating parts rendered the aspect of this group very interesting. Alike so were the subsequent changes. After all the heads had fallen, no germination was perceptible on the 22nd of February. But fifty or sixty buds appeared in forty hours, and in another day that number had doubled. Almost all the twigs were flourishing vigorously on the 2nd of March. Above three-fourths of the heads had fallen

on the 8th, and on the 10th only one remained, which went to speedy decay. In the next place, a few buds again protruded from the extremities on the 29th of April; several flourished on the tallest stem on the 4th of May, and the reproduction of them was again general on the 13th of June.

In short, from these and similar observations, it has been proved: 1st, that the same twig may bear at least six successive Hydræ; 2nd, that the persistence of a Hydra is from six to ten days; and, 3rd, that the interval required for the reproduction of the Hydræ may vary from sixteen days to sixty.

As regards the propagation of Eudendrium, Sir John Dalyell gives the following interesting particulars:—

A splendid group of above fifteen specimens occurred on a live mussel-shell. One of these, not 18 lines high, bore 83 Hydræ, and another, somewhat taller, above 100. At least a thousand animated beings decorated the group—a wonderful assemblage of variety and beauty on such a scale.

Numerous clusters, like yellow ova, were interspersed among the Hydræ, not within the circuit of the tentacula, as with the Tubulariæ, but generally around the exterior of the under surface or base of the disc, though disjoined from it, and sometimes compressing the Hydræ by their number and position. But they were neither confined to any particular place, nor peculiar to the finest specimens. Subjected to the microscope, these substances proved to be of a smooth, uniform surface, exactly resembling minute ovoid plums, attached by short pedicles to some part of the stem, but never within the Hydra. They were

single, in pairs, or in clusters of seven or eight together (Pl. II. fig. 2, *f*).

These yellow plums proved at length to be so many ovaria, analogous to the clustering cysts of Tubularia already described, though differing from these latter in various particulars; for they neither corresponded in position or consistence, nor in the connexion of a number by a pedicle affixing them to one common stalk, nor in their contents.

Each of these minute yellow plums is a separate and independent pod or vesicle, from which is discharged an animal intimately resembling a Planaria, and which Sir John Dalyell designates a *Planula*.

This animal, the *Planula* (Pl. II. fig. 2, *e*), is taper, roundish, or somewhat flattened, not half a line in length, of smooth, uniform, fleshy aspect, and quite destitute of external organs. It crawls along the bottom with considerable activity; and on ascending by the side of its vessel to the surface of the water, it either descends again, or, committing itself to the element, it swims supine: it changes its situation freely, testifying evident preferences, and is of infinitely greater activity than the nascent Hydra discharged from the cyst of Tubularia.

The *Planula* is soft and variable in its form, and it continues crawling about for an indefinite time. Then its motion relaxes, it shortens and thickens, and appears as if composed of two portions, a larger and smaller, both very obtuse, and shortly afterwards it is found fixed to some solid substance. In four days more it becomes altogether metamorphosed, for now it is found changed into a living Hydra, borne on a

tubular stem with a diffusing root below (Pl. II. fig. 2, *g*).

A fine specimen of *Eudendrium ramosum* was obtained towards the end of September, five inches high, and apparently very old, which was remarkable for the profusion of pure white vesicles on the branches, disposed in clusters of five, six or seven together.

Within a few days many *Planulæ*, all pure white, had been discharged by the vesicles corresponding in shape with those above described (Pl. II. fig. 2, *e*), presenting an obtuse rounded head, thick and fleshy body, and tapering towards the tail, which was also obtuse. The number of Planulæ continued augmenting, but in a short time their motion relaxed; they became stationary and quiescent, and the alteration of their shape announced approaching metamorphosis. Meantime a root was diffusing below, and a stomach forming above; and the higher portion, by the refining and improvement of the parts, began gradually to assume the aspect of its species.

Besides the above-described mode of increase, the *Eudendrium ramosum*, wonderful to relate, gives birth, under certain circumstances, to a race of animals widely different from itself both in form and attributes.

Practical naturalists, observes Sir John Dalyell, must be well-aware that numerous colonies of minute Medusæ, and even successive generations of them, sometimes appear in vessels containing various marine collections. But it is extremely difficult to pursue the history and progress of such transparent, unmanageable, and, too often, evanescent beings; their sudden existence has surprised me again and again.

I was unable to ascertain their origin; they have remained some days in activity, and then vanished without leaving the slightest trace behind. No species could be preserved with facility, though but for a short period; they did not seem referable to any particular time or subject; everything regarding them was wrapped in mystery.

While a number of vigorous Hydræ still terminated the extremities of a specimen of *Tubularia* (*Zudendrium*) *ramosa*, I suspended various specimens by silk threads in vessels of sea-water. Several white specks among the twigs issuing from the branches then became perceptible by the naked eye, which, under the microscope, proved to be solid pear-like substances, of a bluish-grey colour. Thence I proposed to call them *Pyrulæ*. Thinking little of the matter at the moment, I concluded they might be regenerating Hydræ, as not unusual with different zoophytes; but my attention was soon arrested by the position of some, as if seated on the long neck of the living Hydra. I could not doubt but that one neck sustained three (Pl. II. fig. 2, *b*), and that elsewhere a cluster of four appeared at the extremity of a twig, then vacant, of a polyp. Further investigation ascertained the following facts:—

Minute pear-shaped bodies (*Pyrula*), as above specified, are dispersed on the stalk of different parts of the zoophyte at considerable intervals; sometimes three are together, sometimes two opposite to each other, or only one terminates a twig where it might be readily supposed a regenerating Hydra. Each *Pyrulum* is affixed by its own distinct pedicle, which

is, at first, of some length, but gradually shortens as the remainder becomes more globular in its shape, until in a few days the *Pyrulum* somewhat resembles the opening bud of a white rose (Pl. II. fig. 2, *a*), in which, strange to say, alternate movements of dilatation and collapse are distinctly perceptible; and to the surprise of the observer, the little rose-bud, in a short time, assumes the elegant proportions and transparent structure of a young Medusa (Pl. II. fig. 2, *c*), from the margins of which four pairs of long tentacular filaments become gradually unfolded, and, after a few convulsive struggles, the newly-formed creature escapes from its enthralment, and appears as a free Medusa suspended amidst the waters.

CHAPTER XII.

HYDRACTINIA.

THE naturalist who confines his attention to the larger and more conspicuous forms of marine productions, neglecting those which, from their minuteness, require the aid of a microscope for their examination, would be but little able to appreciate the scene exhibited upon the exterior of many ordinary shells, when, freshly imported from their home beneath the waves, they are perused attentively with a magnifying-glass. The wonderful variety of animal life that crowds every portion of the surface of some of them, affords a spectacle well calculated to astonish any observer, who, for the first time, contemplates such a scene; and when, upon closer inspection, we perceive how actively employed they all appear, how all find room for life and for enjoyment on the little stage that forms their world, unknowing all beyond, as if creation was confined to them, a reflection by no means unnatural will sometimes steal across the mind, that we ourselves are imaged in their condition, and in their ignorance of what is passing in surrounding nature beyond the sphere of their immediate neighbourhood.

Six thousand years have passed since man was placed upon this sublunary scene—ages untold have

rolled away since these little zoophytes began to live, and toil, and die, and leave behind inscribed in every stone the record of their industry; and yet two centuries have not elapsed since man for the first time suspected their existence—since man first became aware that such things *are*, much less that such things had been, and had perished. Surely the sage was not far wrong who said, that science was a little boy employed in picking up pebbles upon the shore, as specimens of the vast wealth concealed beneath the limitless expanse of ocean.

The *Hydractinia squamata* (Pl. II. fig. 3) is one of those remarkable productions of Nature so singular in its appearance, and so dissimilar in its structure from the generality of the Polyp race, that the young naturalist is at first quite at a loss what to think of it; and were it not for its slow and languid movements when examined under the microscope, it would be difficult to imagine a creature so strangely formed to be a member of the race of Hydroid Zoophytes, to which, on a closer study, it is found indubitably to belong. It is a *Tubularia*, in fact, but widely different in shape from the zoophytes whose history we have hitherto had an opportunity of discussing.

The Hydractinia is one of those animals after which it is vain to institute a special search; nevertheless, an auxiliary frequently comes to our assistance when least expected, a creature most opposite in form, nature and habits—the Hermit Crab.

From the necessity of protecting part of its body, as we shall see afterwards more at length, the Hermit Crab is obliged to take possession of an empty shell,

which it often brings into shallow water, or almost to the shore. Such shells, conveyed by the new tenant from greater depths, are often profusely invested with the animal in question; therefore, the capture of a number of Hermit Crabs, thus sheltered, will give the observer a fair chance of finding specimens of these creatures.

The *Hydractinia squamata* dwells in numerous colonies, which are always implanted on empty shells, such as those of the *Nerita, Murex, Tritonium,* &c.

The animals themselves are single, though numerously associated: a portion of the largest whorl of a decaying shell is sometimes invested by many hundreds of them, resembling a snow-white fleece.

The colony seems to be originally founded on the epidermis of the shell, to which the animal is attached by a slender stalk, enlarging above, so as to present somewhat of a club-shape, whence it has commonly obtained the somewhat inappropriate name of *Coryne* (*κορύνη, a club*). This enlargement or head is environed by from four to about twenty-five tentacula, arranged in successive stages. They are all, together with the summit, very extensile and flexible, and endowed with an adhesive property. Their resemblance to the human fingers is such, that Sir John Dalyell was led to confer upon this zoophyte the name of *Hydra digitata.*

The stomach of the polyp is confined to the dilated portion or head, which is more opake and solid than the medulla in the stalk, and distinctly separated from it behind. Apparently the horny sheath or skin entirely encloses it, but at intervals the paler apex

opens wide for the admission of food. The tentacula are comparatively very short. They sometimes appear to consist of a stout stalk and globular head, which form, however, is merely the result of contraction, for there is no appearance of this globosity in the active and vigorous polyps. The stalk is solid and colourless, tapered gently upwards, and coated with a very thin and faintly wrinkled skin, while the head is white or faintly coloured, and muricated or roughened with sharp points. Mr. Lister says that it is covered with short projections like blunt hairs, and it seems to be by their means that the polyps attach with a touch, or release at will, substances that drift within their reach. According to Mr. Hassall, the murications seem to be "minute cups, similar to those of the cuttle-fish." This discrepancy Dr. Thompson ascribes to the different manner in which probably the observations upon the organs in question have been made. Lister's description accords well with what is observed when the head is seen at freedom, and the appearance of cups is only produced when the animal is viewed compressed between plates of glass. The granules or blunt hairs appear to be of a glandular nature, secreting a tenacious mucus. When brought in contact with a foreign body, the tentacula instantly adhere to it with sensible firmness, and the act is too instantaneous to be the result of the application of suckers, or of any power dependent on muscular action. But sometimes a film or line may be seen stretched between the foreign object and the head of the tentaculum, when this is naturally withdrawn by the animal itself.

On a first glance, we are apt to imagine that the tentacula could be of little service to the polyp, for even when they have fixed the errant prey, their shortness must prevent them from conveying it to the mouth. This is true; but the difficulty is obviated by the mobility of the head, which can not only be shortened and lengthened at will, but can be turned in any direction, so that its extremity may be applied to whatever tentaculum the prey is adherent to.

Colonies of these Hydractiniæ in a contracted state, when first taken from the sea, resemble a gelatinous crust investing the shell. They are liable to become covered with a kind of mouldiness in still water; whence it is probably a provision of nature to ensure constant washing, that they frequent shells occupied by so restless an animal as the Hermit Crab.

The mode of reproduction in the Hydractinia resembles in some respects that of the Tubularia above described. Clusters of ovarian capsules are produced immediately below the inferior row of tentacles (Pl. II. fig. 3). These capsules are observable in all stages of development, each being supported upon a very short pedicle, and in their interior may be perceived one, two, or even four embryonic corpuscles, each contained in its own compartment: these, as they become mature, escape into the surrounding water, at which time they present the appearance of minute Hydræ, and if placed in a watch-glass, these little corpuscles soon become adherent thereunto, and gradually assume the form of their parent.

CHAPTER XIII.

SERTULARIAN ZOOPHYTES.

Few amongst our lady readers but have amused themselves during the leisure hours of their visits to the sea-side in collecting upon the shore, selected from among the thousand elegances which, known by the general name of sea-weeds, strew the beach in rich profusion, those branching, horny corallines, whose slender stems and spreading plumes, arranged after various graceful patterns, at once attract the eye and extort expressions of delight from lips best adapted to criticise what is beautiful in creation (Pl. II. fig. 4).

Occasionally we are indulged with a sight of similar delicate arborescences spread out on cards, and grouped in tasteful combinations, or, more favoured still, enshrined in albums, with an appended poetical appeal to our feelings (quite irresistible in our case) to

"Call them not weeds, but flowers of the sea."

Admirable certainly are these pretty objects, thus embalmed by roseate fingers, even in the dried and shriveled state in which they are thus presented to our notice, but infinitely more worthy of our admiration

when, in full health and vigour, they unfold before us, as they flourish luxuriantly in their native element, their wondrous attributes, and teach us how objects, apparently so insignificant, may surpass our highest imaginings.

It is not however upon the beach that the SERTULARIAN ZOOPHYTES (for by that name we must now introduce these exquisite productions of the ocean to the non-scientific) are to be obtained, if we wish to observe them in a living state: they must be sought for in their native haunts, in some deep pool, for instance, when the tide is out, wherein they will be found growing on shells or stones. They must be handled tenderly, and cautiously brought home, together with the shell or stone to which they are attached, and carefully located in their new abode, where, after a little time, they will begin to manifest their real nature, and reveal the countless polyps, which, lodged in appropriate cells, are the inhabitants of every branch.

Truly it is a glorious spectacle to watch one of these corallines when in full life and activity, and astounding to reflect upon the scene thus exhibited, to estimate the numbers of the little busy polyps that are there so silently employed, so actively engaged, so busily and yet so blindly cooperating in the construction and support of their numerous colony!

Each plume, says Mr. Lister, in reference to a specimen of one of these zoophytes (the *Plumularia cristata*), might comprise from 400 to 500 polyps, and a specimen of no unusual size before me has twelve plumes, with certainly not fewer cells on each

than the larger number mentioned, thus giving 6000 polyps as the tenantry of a single polypidom! Now, many such specimens, all united too by one common fibre, and all the offshoots of one common parent, are often located on one sea-weed—the site then of a population which neither London nor Pekin can rival. But *Plumularia cristata* is a small species, and there are single specimens of *Plumularia falcata* or *Sertularia argentea* to be met with in equal abundance, of which the family may consist of 80,000 or 100,000 individuals. Such are the "insect millions peopling every wave."

The extremities of the stems of the TUBULARIÆ described in a preceding chapter are simply cylindrical, and unprovided with any cavity into which the terminal Hydræ can be withdrawn. But the extremities of the SERTULARIÆ present cup-like cells, and a multitude of similar cells are implanted on the stem, boughs and branches, of various configuration in different species, into which the hydriform polyps can retreat for shelter. Some of these cells are little more than a simple orifice; some resemble a tooth, a cup, a flask or a bell with a smooth or serrated lip. Some are armed with a longer or shorter spine, or the margin of others is guarded by several extraordinary processes, extending in straight lines, or in curvatures of inordinate length. These cells, with their tenants, stand on one or both sides, or are arranged around the central stems. They may be placed singly, at distant intervals, in pairs or in clusters, either crowded together or far apart. Sometimes they are seated on stalks or branches, or twigs, jointed, whorled or frilled;

in short, the greatest variety is exhibited throughout the principal and subordinate parts of these elegant zoophytes, which nothing but a copious series of accurate delineations from luxuriant specimens could illustrate, but which the reader may easily become acquainted with by the assistance of a pocket lens, while strolling upon the shore.

The vigour and disposition of the tenant polyps are sensibly modified by these provisions for security. Instead of exhibiting the inactive languor of the naked Hydræ, each little Sertularian polyp is seen to be quick and lively in its motions. As if conscious of danger, it lurks at the bottom of its receptacle; it is cautious of advance and precipitate in retreat. While completely unfolded, all its organs suddenly collapse; it sinks within the cell in a moment, and crouching still lower and lower, lies quiescent, until, the dreaded peril over, it rises slowly as before, again to expand itself. Now the whole is still, and apparently lifeless, like a plant shorn of its flowers and foliage in the winter-season—it seems hastening to decay. Let it remain undisturbed, and in a few moments it will be covered by innumerable animated blossoms, issuing forth from their cavities and spreading themselves out in the light, and then, after seeking their enjoyments in the plenitude of evolution, they again vanish in instant retreat.

The food of the Sertularian zoophytes seems to be entirely derived from the microscopic organisms which are contained in the surrounding water. Nevertheless this is a question which, simple as it might appear, is by no means satisfactorily determined, and it

is more than possible that these polyps may be endowed with a power of seizing and devouring prey of a higher description, as is known to be the case with their great prototypes, the Hydræ properly so called. We at least invite the attention of the observer to this part of their history, about which naturalists are at present much in the dark.

Whilst experimenting on a specimen of *Sertularia* (*Plumularia*) *falcata*, Sir John Dalyell observed a very remarkable circumstance in the economy of these zoophytes. Having cut some specimens near the root during the month of December, and subdivided the severed stalk of each into several portions, he was surprised to observe vigorous reproduction ensue from *both* extremities of each of the separated fragments; all the new stems thus produced becoming in the course of a few days furnished with numerous hydriform polyps, and evidently capable of continuing this mode of increase to an indefinite extent. Every part of the zoophyte would therefore seem to be endowed with vital energy quite irrespective of the rest.

The life of the specimen is dependent on the subsistence of the pith: the life of each individual polyp on its connexion with the common stem. The life of each of a thousand Hydræ, though all supported on the same polypary, and rising from the same root, is, however, quite independent of that which animates all the rest, and the death of no one individual seems to affect its neighbour. While the parts above and below are in absolute decay, an intermediate branch may exhibit all its vigour in luxuriant florescence. In the natural state the decay commences with the

lower ramifications; nevertheless, the persistence of vigorous animated extremities may be long, and their reproductions numerous, while all the lower ramifications are quite dead.

Let us, however, illustrate the economy of these beautiful organisms by an example.

SERTULARIA POLYZONIAS. *The Hoop Sertularia.*

Specimens of this zoophyte rise to about 4 inches high, by a stem which is slightly waved, and scantily provided with boughs and branches diverging to right and left. The cells are ranged alternately on both sides of the stem, the subordinate parts always originating from the convexities by which these are distinguished (Pl. II. fig. 6).

Each cell is occupied by a Hydra furnished with about twenty-four or twenty-six tentacula (Pl. II. fig. 6, *a*). The Hydra is large in proportion to the size of the cell, from which it protrudes by means of a long neck or body; and, when disturbed, retreats completely within the cavity. The whole zoophyte is of a green colour, of various shades and intensities, this colour being derived from the pith, as the horny sheath is perfectly transparent. The stem of adults or older specimens is occasionally yellowish or brown.

The ovaria or reproductive vesicles of this Sertularian are large in comparison with the cells, and of singular structure, appearing as if they were composed of hoops or belts united together (Pl. II. fig. 6, *b*).

Specimens with lively Hydræ, and bearing reproductive vesicles, were obtained by Sir John Dalyell in July. Only one vesicle appeared among twenty cells.

Those that were prolific extended about a line in length, and were filled with yellow, globular corpuscles, about twenty-four in each (Pl. II. fig. 6, *b*, *d*).

About fifty *Planulæ* issued from the different vesicles on the 8th of July. These were about a third of a line in length; the body plump, nearly round, but somewhat flattened below; of a smooth, uniform aspect, and darker in colour than straw-yellow. In the course of their escape they were evidently suspended from various parts of the specimen by an invisible thread; but, on reaching any solid surface, they advanced with an equal gliding motion, resembling *Planariæ* (Pl. II. fig. 6, *c*).

Many *Planulæ* continued quitting the vesicles from the 8th to the 12th of July. They spread on the bottom, and crowded together on the sides of their vessels. Numerous dark green, thick, obtuse *spines* were observed rising from spots on the bottom of the glasses (Pl. II. fig. 6, *g*); and, on the 14th of the month, several of these had evidently enlarged as buds (Pl. II. fig. 6, *f*), which, next day, and on the day following, had in many instances become developed into Hydræ (Pl. II. fig. 6, *g*). The *spine* is at first dark green, thick and obtuse; when further advanced, the summit enlarging exhibits the Hydra as a green bud within its cell, the "spine" becoming the sustaining stalk. Also the green colour of the stem demonstrates the existence of a central pith.

Illustrations of the process of progressive growth may likewise be witnessed in this Sertularia in its earliest stages. An enlargement appears at the summit of a stalk, which is found to be invested by a deli-

cate thin film, including twin buds. These are unequally advanced; but as the lower one becomes matured, its higher companion forks off, and then another is developed from this latter in the same manner. The buds are nascent Hydræ in their respective cells, each having apparently its own peculiar integument within the common filmy involucrum.

Rapid growth ensues. A young specimen with only a single head on the 4th of October, had acquired six on the 20th, besides a seventh in embryo; and of course, as the extent of the zoophyte increases, and the branches become more numerous, the evolution of additional polyps becomes proportionably more rapid.

The multiplication of these elegant zoophytes appears therefore to take place in three different modes: 1st, by cuttings, as in plants; 2ndly, by offshoots, or the formation of new branches bearing polyps; and 3rdly, by *Planulæ*, capable of locomotion.

The first mode strikingly resembles what is observed in the vegetable kingdom; for as every branch of the plant-like body contains all the parts necessary for independent existence, it can hardly be a matter of surprise, that any portion separated from the rest will continue to grow and thrive as well as the entire colony.

The second mode of increase, namely, by the formation of new branches and polyps, seems more like the growth of a plant than the development of an animal; while the third is evidently specially intended for the diffusion of the species.

CHAPTER XIV.

CAMPANULARIAN ZOOPHYTES.

THERE is a great resemblance between these Zoophytes and the Sertularians described in the preceding chapter, insomuch indeed that the reader will find it difficult to distinguish them.

The CAMPANULARIÆ may, however, be recognized by the following characters. The polyp-stems, which are plant-like and horny, are rooted by a creeping tubular fibre, either branched or simple. The polyp-cells are thin and *campanulate*, that is, bell-shaped, and, moreover (instead of being, as in the Sertularians, sessile upon the sides of the stem and branches), are in the Campanulariæ terminal and elevated on foot-stalks, which are disposed either alternately or in an irregular manner. The germs of progeny are developed, as in the Sertularians, in horny, deciduous capsules, or "reproductive vesicles," as they are termed; but the young, instead of presenting the form of Planulæ, or resembling young Planariæ, make their appearance as *Medusæ*, thus affording another remarkable example of Medusiparous birth.

We have already found among the Hydroid Zoophytes, that the Medusiparous mode of reproduction

is by no means a phenomenon of unfrequent occurrence in this remarkable class, and yet, until a very few years ago, such a circumstance in their history was not only entirely unknown, but, when first announced to exist, the discovery was received by naturalists with as much hesitation and jealous caution, as if some visionary enthusiast had endeavoured to impose upon their credulity.

Animal magnetism and table-turning found ready advocates; the upholders of clairvoyance and spirit-rapping had no difficulty in making converts to their mysteries; but to believe that a polyp could give origin to a jelly-fish, or a jelly-fish to a polyp, was esteemed to be an assertion so incredible, that nothing but the well-known simple truthfulness of its first discoverers could have obtained a hearing in support of statements apparently so monstrous and absurd.

"If, in a picture, Piso, you should see a horse's body with a fish's tail, and limbs of beasts of the most different kinds covered with feathers of all sorts of birds, would you not laugh, and think the painter mad*?" was a question easily propounded, and still more readily answered, until at length the notion of these alternations of form in the Hydrozoa might have been scouted as incredible and preposterous, had not the evidence of our own senses, the aquarium and the microscope, asserted the reality of the fact, and compelled the belief of the most sceptical:

"Serpentes avibus geminentur, tigribus agni."

The subject of the present chapter affords us another opportunity of elucidating this wonderful pro-

* Horace, De Arte Poetica,—freely translated.

cess; and from the circumstance of its being exceedingly manageable, and easily examined in a watch-glass under the microscope, will frequently be found a favourite inmate of the marine vivarium. Campanulariæ of various kinds are, moreover, to be met with on every coast; so that, with a little industrious searching, the student of Nature will find no difficulty in procuring specimens wherewith to verify the following circumstances connected with their history.

The CAMPANULARIA DICHOTOMA, or *Sea-thread Coralline* (Pl. II. fig. 5), is one of the most delicate, elegant, and interesting among the numerous race of arborescent zoophytes. It is invariably found attached to some foreign object, from the surface of which it rises erect by a dark brown tubular stem, extremely slender, being truly no thicker than a silken thread, but tough and elastic. The polypary, as in the rest of this Order, is occupied by an internal pith, and in each of the little bells or cups which terminate the individual branches is lodged a hydriform polyp, in all respects of the same nature as those we have already described. This coralline is of great luxuriance: before a specimen has attained the height of an inch, it may bear from 50 to 60 Hydræ, and on a specimen nine inches high, upwards of 1200 little polyps have been counted.

The mode of propagation in the *Campanularia dichotoma* constitutes, however, the most interesting part of its history, and will furnish abundant matter of research to every student in this department of the domain of Nature.

At certain seasons numerous egg-shaped vesicles

(Pl. II. fig. 5, *v*) may be detected amongst the usual polyp-bearing cells, in the proportion of about one of the former to thirty of the latter. Their position is no farther peculiar than in being seated on the upper side of the branches, and they are generally empty, as if they had fulfilled the purpose for which they were intended. When present, their number on a branch sometimes amounts to eight or ten.

These vesicles are of a grey, or a greenish colour. When prolific, they contain twelve or more dull grey corpuscula, each having a dark central nucleus, and all appearing as if compressed together (Pl. II. fig. 5, *a*). These little bodies, be it remarked, present no resemblance to the contents of the vesicles of the *Sertulariæ*, which, as we have seen, make their escape under the form of active *Planulæ*, but are evidently of a very different nature, and well calculated to rivet the attention of the most incurious who may be fortunate enough to procure them under circumstances favourable for observing their strange history.

When the contents of the reproductive vesicles of the Campanularia approach maturity, some internal movement becomes perceptible towards the upper part, and at length the tips of the tentacula of an included animal make their appearance, gradually protruding from the summit of the vesicle, and these stretching further outwards, soon (Pl. II. fig. 5, *b*) begin to contract convulsively, as if to free the body within. After much apparent exertion this is at last accomplished, and we behold, to our astonishment, a *Medusa*, which has escaped from its prison! (Pl. II. fig. 5, *c*, *d*).

At first, says Sir J. Dalyell, I could scarcely credit the truth of so unusual an occurrence, presenting such a remarkable deviation from the nature of the progeny discharged by the vesicles of the various Sertularian tribes, but I was unable to recognize any error either in the previous existence of the Medusa within the vesicle, or in its liberation from it. I have since, however, seen the same repeated many times, though at distant intervals.

When originally observing similar minute Medusæ before ascertaining their origin, Sir John Dalyell had no doubt that they were little Acalephæ, and had not inaptly bestowed on the young creature the name *tintinnabulum,* from its resemblance to a hand-bell (Pl. II. fig. 5, *d*). The body in fact might be compared to a minute watch-glass, half a line in diameter, bordered by a pendent marginal fringe of about twenty-three tentacula, each of which issues from an enlarged root, and is nearly as long as the diameter of the disc. A central prolongation below corresponds to the proboscis of the Medusa, while the animal suspends itself *in equilibrio* in the water; but when reversed, this proboscis appears like a crest upon a convex surface (fig. 5, *d*): four lines with enlarged extremities diverge from the base of this proboscis. The animal is whitish, or almost transparent. It swims by jerks, like the various species of Medusæ, pursuing all directions, rising, falling, or remaining stationary; and, like the *Medusa bifida,* a group of these little creatures closely resembles a flock of minute birds wending their course through the expanse of the firmament.

The astonishment of Prof. Van Beneden on first discovering the Medusiparous character of the Campanulariæ seems to have fully equalled that of Sir John Dalyell, and his account of the phenomenon is very similar to that given above.

Happening to have in his aquarium sundry specimens of these zoophytes, he was occupied one morning, as usual, in examining them with a lens, when he perceived the water to be crowded with hundreds of minute Medusæ, some of which he caught for the purpose of examining them under the microscope, and then proceeded to make an accurate drawing of one of them, preparatory to writing a description of its appearance. In about an hour afterwards, on again looking at this specimen, he was amazed to find its shape altogether changed, and the animal apparently turned inside out. The marginal tentacles seemed to be reversed in their position, the umbrella-like disc from being convex had become concave, and the central pedicle of the Medusa seemed converted into the stem of a solitary polyp; here, however, his observations ceased, and we commend to the special attention of our sea-side naturalists his further notions relative to the history of the Medusa-like polyp, in order that they may be either verified or disproved by actual examination of what really takes place.

"My observations," says Professor Van Beneden, "go no further; but, although I have not seen the polyp (Medusa) give origin to a polyp-stem, I observed it up to the moment when it was about to form a new colony; and without fear of deceiving ourselves, we may form by analogy some idea of the changes

which must necessarily occur. The *Campanularia* in its Medusa-state has only a single aperture, situated at the extremity of its central pedicle. We have already seen that its body becomes inverted like the finger of a glove, and that the marginal filaments become converted into true tentacles. The polyp fixes itself by the extremity of its central appendage, that is, by what was previously its mouth. The back of the umbrella becomes depressed at the same time that the tentacles change their direction, and in the centre of the disc a new aperture is formed, which communicates with the central cavity, and becomes the permanent mouth, which is situated directly opposite to the original one. Being now fixed by its base, the body of the polyp begins to grow; and as its external sheath becomes hardened, buds sprout at regular intervals from its surface. In a word, the growth of the polyp resembles that of the Hydræ, with this difference, that in the latter there is no polyp-stem, and their buds sprout from another part of the body."

Such is Van Beneden's "idea derived from analogy." We shall be delighted if any of our readers should fortunately have a favourable opportunity of putting science in possession of the real proceeding of Nature in this matter.

CHAPTER XV.

CARYOPHYLLIA.

THE natural productions which have so long occupied our attention were denominated Zoophytes, because by some physiologists they were thought to partake of the nature both of vegetables and animals, and connected the two kingdoms of organized nature; or, as the term is now understood, because, having the outward semblance of sea-plants, they are in reality the formations of little animals that nestle in the tubes of the zoophyte to which they are organically and indissolubly connected.

Little more than a century has elapsed since the first discoveries were made upon which this last view of their economy originated. Previously to that time, zoophytes were considered the undoubted subjects of the vegetable kingdom, naturalists being obviously led to this allocation of them by their arborescent appearance, in which it were vain to attempt to trace a resemblance to the more usual forms exhibited by animals, and by their permanent fixedness to the objects upon which they grow; for zoophytes are attached to foreign bodies much in the same way that marine plants are, while the capability of moving from place to place was deemed to be the principal cha-

racter of distinction between the two classes of animated beings. The zoologist claimed none of them, if we except the *Actiniæ*, for his province and study, but left them, without dispute, to botanical writers; and if any of these, in reference to a very few zoophytes of the less arborescent character than the rest, hazarded a whispered conjecture that they were wrongly classed, it died away in the utterance, and raised no echo to awaken further inquiry.

The only opposition to the botanical theory came from the mineralogists, who, some of them, questioned the vegetability of such of these productions as were of a hard and stony nature, contending that they were rather rocks or stones formed by the sediment or agglutination of a submarine general compost of calcareous and argillaceous materials, moulded into the figure of trees and mosses by the action of the waves, by crystallization, by the incrustation of real fuci, or by some imagined vegetative power in brute matter*.

It was only somewhere about the year 1730 that Peyssonnel, a physician residing at Marseilles, whose opportunities of observing these organisms entitled him to give an opinion upon the subject, first ventured to maintain, that what had previously been described as the "blossoms" of the coral, were true animals ("insects," he thought proper to call them), analogous to the Actiniæ or Sea-Anemones; that the coral was secreted in a fluid form by the inhabitant Actiniæ, and became afterwards fixed, hard, and changed to stone; and that all other stony plants, and even

* Johnston, Brit. Zoophytes.

sponges, are the work of different "insects" peculiar to each species of these marine productions, which labour uniformly according to their nature, and as the Supreme Being has ordered and determined.

Jussieu, whose eyes had been opened to the real nature of the zoophytic races by the arguments of Peyssonnel, although, truth to say, he seems to have been convinced sorely against his will, at last declared his complete faith in the animality of these creatures, and his conviction that a numerous list of productions, hitherto unexamined, would be found to be of the same nature; in fact, he seems to have revelled in the enjoyment of the prospect thus revealed before him. "All that we have said," he thus concludes, "of the polyps of the sea is merely a sort of advertisement, which, however, cannot fail to produce the effect which we promise ourselves from it; it will doubtless direct the curiosity of naturalists who reside by the sea to animals so worthy of being better known. They will seek out different species; they will delight to describe to us the varieties presented in their forms, which are never but remarkable; they will study the figure and disposition of the cells of various species, their manner of growth and reproduction, and wherewithal they are nourished; they will place in a clear light everything that has reference to the different polypidoms and their formation, so that a department of natural history so interesting, so new, and as yet only sketched in outline, may be rendered as perfect as it merits to be." They will;—but here we must fancy the enthusiastic old gentleman, in the exuberance of his delightful anticipations, flinging his hat

and spectacles into the air; and could he but have added, "they will have aquaria wherein to keep them alive," his well-powdered peruke would, as we may imagine, have speedily followed them in his frantic exultation.

It is wonderful with what difficulty the plainest truths are admitted by those whose minds are prejudiced against them. The researches of Peyssonnel and the enthusiasm of Jussieu met with a reception equally repulsive among their contemporaries, at least in this country, and the mineral theory still found advocates. Even in the year 1753 we find no less a personage than Henry Baker, the author of the celebrated work, "Employment for the Microscope," gravely writing as follows:—

"The rocks in the sea on which these corals are produced are undoubtedly replete with mineral salts, some whereof, near their surface, being dissolved by the sea-water, must consequently saturate with their saline particles the water around them to a small distance, where, blending with the stony matter with which sea-water always abounds, little masses will be constituted here and there, and attached to the rocks. Such adhering masses may be termed roots, which roots attracting the saline and stony particles according to certain laws in nature, may produce branched or other figures, and increase gradually by apposition of particles, becoming thicker near the bottom, where the saline matter is more abounding, but tapering or diminishing towards the extremities, where the mineral salts must be fewer in proportion to their distance from the rock whence they originally proceed; and

the different proportions of mineral saline particles of the stony or other matter with which they are blended, and of marine salt, which must have a considerable share in such formations, may occasion all the variety we see. Nor does it seem more difficult to imagine that the radiated, starry, or cellular figures along the sides of these corals, or at the extremities of their branches, may derive their production from salts incorporated with stony matter, than that the curious delineations and appearances of minute shrubs and mosses on slates, stones, &c. are owing to the shootings of salts intermixed with mineral particles; and yet these are generally allowed to be the work of mineral steams and exhalations, by which must, I think, be meant the finest particles of some metal or mineral incorporated with, and brought into action by, a volatile penetrating acid, which, carrying them along with it into the fissures at least, if not into the solid substance, of such stones or slates, there determines them to shoot into these elegant branchings, after the same manner, and frequently in the same figures, as the particles of mercury, copper, &c. are disposed and brought together by the salts in aqua fortis*."

Such was the murky atmosphere of Nature's laboratory, in which our countryman, John Ellis, found himself plunged when he first undertook his work on British Zoophytes—such was the Stygian gloom his labours dissipated. We ought, indeed, to apologize to our readers for detaining them so long from the

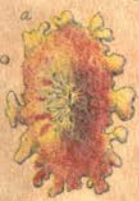
* "Employment for the Microscope," pp. 218–220. Lond. 1753.

pure light of day, more especially as a few sunshiny hours, devoted to the contemplation of the animals that next invite our notice, will do more in the way of enlightening us concerning the real nature of the Madreporic rocks than whole volumes of learned disquisitions.

We must not, however, in this climate, expect to find the "coral-fields" exhibiting their full luxuriance; it is in regions where the sun "showers triple heat" that they appear in all their glory, rivalling, if not surpassing, the gay charms of their terrestrial sisterhood. Beneath the tropics they abound in rich profusion, and trees and shrubs, and plants of various kinds, have each their representatives beneath the wave. The choicest garden does not offer flowers more graceful in their form, or ornamented with more beautiful colours, than those of the coral-reef; and we may add, too, that the birds of the groves do not excel, in the richness of their hues, the fishes that sport amongst the coral branches. The coral-tree, it is true, is without verdure, but there is full compensation in its perpetual bloom.

The masses of Madrepore that enrich the cabinets of the curious are familiar to every one; but it is the privilege of few to study these as they grow upon their native beds. Their calcareous skeletons present a vast variety of form, branched or in rounded masses, or spread out in broad expansions, but at once recognizable by the concentric laminæ, variously disposed, whereon the living polyps rest; for, when alive, the stony substance is incrusted with a living flesh, from which arise at intervals rosettes of tentacles resem-

PLATE III.



bling flowers, which are, in fact, Actiniæ, in all essential points, allied to the Sea-Anèmones, to be described in a succeeding chapter.

The visitor to our southern coasts, while dreamily reclining over the side of his boat, to peer into the transparent sea, will sometimes notice, as he glides along over the rocks, in shallow water, the *Caryophyllia Smithii* (Pl. III. fig. 2), one of our few native specimens belonging to the race of Madreporic Zoophytes, the history of which its habits will well serve to illustrate.

When the soft parts of Caryophyllia are fully expanded, the appearance of the whole animal resembles very closely that of an Actinia. When shrunk, they are almost entirely hid among the radiating plates. Specimens rarely occur above an inch in diameter. They are found at Torquay pendent from large boulders of sandstone, just at low-water mark; sometimes they are dredged from the middle of the bay. Their colour varies considerably; the living crust may be white, yellowish, orange-brown, reddish, or apple-green. The tentacula are usually paler. During expansion, the soft parts rise above the level of the disc to about twice its height. The tentacula are pushed forth very slowly, but sometimes are as long as the whole height of the body; they are nearly transparent, except at their termination, which is dilated into a little ball, white and opake. The mouth has the appearance of an elongated slit in the centre of the disc; it is prominent, and the lips are marked with transverse striæ of a white colour. When a solid body is brought gently into contact with the

tentacles, they adhere pretty strongly to it, just as the Actiniæ do; but when they are rudely touched, they contract very quickly; and, if the irritation be continued, the whole soft parts sink within the calcareous cup.

Expanding its delicately tinted arms in the quiet recesses of an aquarium, the Caryophyllia is a truly beautiful object, and, as it seems to be lazily enjoying the sunshine, few would suspect the importance of its labours—few would dream that these apparently insignificant animals, by the accumulations of their calcareous skeletons, form the reefs and coral islands of tropical seas—the dread of the navigator—the admiration of the lover of the picturesque—the subjects of the closest and most interesting speculations to the naturalist and geologist.

That masses of rock, many leagues in extent, should be founded in the depths of the ocean, and built up to the height of hundreds of feet, by minute, frail, gelatinous creatures such as these, is indeed a phenomenon calculated to astonish the unversed in zoological science,—a fact which has demanded the repeated observation of the most accomplished naturalists and enlightened voyagers to render it intelligible, and the language of poetry to describe the result of their united labours.

"Millions of millions thus, from age to age,
With simplest skill and toil unwearіable,
No moment and no movement unimproved,
Laid line on line—on terrace terrace spread,
To swell the heightening, brightening gradual mound,
By marvellous structure climbing toward the day.

Each wrought alone, yet all together wrought
Unconscious, not unworthy instruments,
By which a hand invisible was rearing
A new creation in the secret deep.
Omnipotence wrought in them, with them, by them;
Hence, what Omnipotence alone could do,
Worms did. I saw the living pile ascend,
The mausoleum of its architects,
Still dying upwards as their labours closed:
Slime the material, but the slime was turn'd
To adamant by their petrific touch:
Frail were their frames, ephemeral their lives,
Their masonry imperishable."

MONTGOMERY, *Pelican Islands.*

These zoophytic productions present themselves under three principal forms, "*atolls*," "*barrier-reefs*," and "*fringing reefs**."

The term "*atoll*" is the name given to the coral islands, or lagoon islands, in the Indian Ocean, by their inhabitants. An atoll consists of a wall or mound of coral-rock rising in the ocean from a considerable depth, and forming a ring, or circular island, with a lagoon or sheet of water in its interior. The outer wall is generally breached in one or more places, and, when the breach is deep enough to admit a ship, the atoll affords a convenient and safe harbour. The outer side of the atoll usually sinks to a depth of from two to three hundred fathoms, shelving at an angle of forty-five degrees or more; the inner side slopes gradually towards the centre of the lagoon, forming a saucer-shaped cavity, the depth of which varies from one

* Darwin, Structure and Distribution of Coral Reefs. 8vo, 1842.

fathom to fifty. The summit of the exterior margin of the reef or wall is usually composed of various species of living *Porites* and *Millepora*. The *Porites* form irregular rounded masses of from four to eight feet broad, and of nearly equal thickness: other parts of the reef consist of thick, vertical plates of the *Millepora complanata*, intersecting each other at various angles, and forming an exceedingly strong honeycombed mass. The dead parts of these calcareous skeletons are often incrusted over with a layer of the marine vegetable called *Nullipora*, which can better bear exposure to the air.

This strong barrier is well fitted to receive the first shock of the heavy waves of the fathomless ocean without, and, what at first appears surprising, instead of wearing away at its outer edge, it is only here that the solid wall increases. The coral animals thrive best in the surf occasioned by the breakers. Through their agitation, an ever-changing and aërated body of water washes over their surface, and their respiration is maintained in the highest state of activity. Abundant animalcules, and the like objects of food, are thus constantly brought within the sphere of the tentacula of the hungry polyps. Their reproductive gemmules are rapidly and extensively dispersed amongst the crevices of the calcareous mass, and thus rising colonies are planted wherever fit situations occur for their support and protection.

By the force of unusual storms, this outer reef is occasionally breached, and huge masses are torn off and driven towards the lagoon, where they form an inner barrier or reef. The broken surface becomes

the seat of attachment of the young of the neighbouring corals, the successive generations of which, by their rapid growth, and development of their calcareous skeletons, soon repair the damage caused by the storm. The masses of broken coral, thus driven inwards towards the lagoon, accumulate in time to the height of some feet above high water. These fragments are mixed with sand and shells, and form a favourable soil for the growth of vegetables, such as the cocoa-palms, the large nuts of which may be borne hither by currents of the ocean from very distant shores. Turtles likewise float to the nascent island, browse on the sea-weeds that grow in the lagoon, and breed there. Numerous species of fishes and shell-fish flourish in the same still water, which abounds with animal life. Man comes at last and takes possession of the island, and the cocoa-nut, the turtle, and the fish, afford him abundant and wholesome food:—

> "The turf looks green where the breakers roll'd,
> O'er the whirlpool ripens the rind of gold;
> The sea-snatch'd isle is the home of men,
> And mountains exult where the waves have been."

But it may be asked, how does he supply himself with that necessary of life, fresh water? This is obtained in a very simple and unexpected manner, from shallow wells dug in the calcareous soil, which ebb and flow with the tides, and yet are almost wholly free from the saline particles of the ocean. Some have supposed that the sea-water loses its peculiar salts by infiltration through the calcareous mass. Mr. Darwin thinks that it is derived from the rain-water, which,

being specifically lighter than the salt, keeps floating on the surface, and is subject to the same movements; howsoever this may be, the fact is certain. A fit and convenient abode is thus fabricated by the action of the feeble, gelatinous polyps, and a wild and almost boundless waste of waters becomes enlivened by oases which navigators have described as earthly paradises.

A *barrier-reef* is essentially similar to the atoll or coral-island. It runs parallel with the shores of some larger island or continent, separated, however, from the land by a broad and deep lagoon-channel, and having the outer side as deep and steep as in the lagoon island. Here likewise the skeletons of the zoophytes of which the reef is composed are found on the outer precipitous wall as deep as sounding-line can reach.

The third class of coral productions, called by Mr. Darwin "fringing-reefs," differ from the barrier-reefs in having a comparatively small depth of water on the outer side, and a narrower and shallower lagoon between them and the mainland.

These differences in the characters of the wonderful fabrications of the coral-producing polyps are explicable by the following facts in their history. The animals of the *Porites* and *Milleporæ* cannot exist at a greater depth than twenty or thirty fathoms; beyond this, the stimuli of light and heat derived from the solar beams become too feeble to excite and maintain their vital powers. On the other hand, their tissues are so delicate, that a brief direct exposure to the sun's rays kills them; and unless they are constantly immersed in water or beaten by the surf, they cannot

live. Thus, in whatever situation the skeleton of a Madrepore or Millepore may be found, it is certain that it must have grown within thirty fathoms of the surface of the ocean. When it coats the summit of the lofty mountain of Tahiti, where Mr. Stutchbury found a regular stratum of semi-fossil coral at 5000 and 7000 feet above the level of the sea, it must have been lifted up by the elevation of the rock on which it was originally deposited. If it is brought up from the depth of 200 or 300 fathoms, as at Cardoo Atoll, or Keeling Atoll, it must have been dragged down to that depth by a gradual subsidence of the foundation on which the living Madrepore once flourished. It is by these movements of upheaval and subsidence of the earth's crust that Mr. Darwin explains the different forms which the coral reefs assume. Elizabeth Island, which is eighty feet high, is entirely composed of coral rock. The coral animals, thus progressively lifted up above their element, are compelled to carry on their operations more and more remote from the former theatre of their constructive energies, but cannot extend deeper than their allotted thirty fathoms; the direction of their submarine masonry is therefore centrifugal and descending. Where the land that supports them is, on the contrary, in a state of submergence, they are compelled to build their edifices progressively higher, and in a narrower circuit; in other words, their growth is centripetal and ascending;—the terms 'ascending' and 'descending,' of course, only applying in this case to the relation of the coral builders to the unstable land, not to the level of the unchanging sea."

The prodigious extent of the combined and unintermitting labours of these little world-architects must be witnessed in order to be adequately conceived. They have built up a barrier-reef along the shores of New Caledonia for a length of four hundred miles, and another which runs along the north-east coast of Australia 1000 miles in extent. Now, assuming this latter to be only a quarter of a mile in breadth and 150 feet deep, here is a mound compared with which the walls of Babylon, the great wall of China, or the Pyramids of Egypt are but children's toys; and built too amidst the waves of ocean and in defiance of its storms, which sweep away the solid works of man.

"The geologist," says Professor Owen, "in contemplating these stupendous operations, appreciates the conditions and powers by which were deposited in ancient times, and under other atmospheric influences than now characterize our climate, those downs of chalk which give fertility to the south coast, and many other parts of our native island. The remains of corals in these masses, though allied in their general nature, are specifically distinct from the living polyps which are now actively engaged in forming similar fertile deposits on the undulating and half-submerged crust of the earth washed by the Indian and Pacific Oceans. Again, those masses of limestone rocks which form a large part of the older secondary formations, give evidence by their organic remains that they too are due to the labours of polyps, the species of which perished before those that formed the cretaceous strata were created. As the polyps of the secondary epochs have been superseded by the *Porites, Milleporæ, Madre-*

porœ, and other genera of calcareous Anthozoa of the present day, so these, in all probability, are destined to give way in their turn to new forms of essentially analogous Zoophytes, to which in time to come the same great office will be assigned, of clothing with fertile limestone future rising continents."

CHAPTER XVI.

ACTINIÆ.

"THE works of Nature far exceed what we know, or are able to know of them. Convinced of this truth, and in order to improve my customary walks by the sea-side to some useful purpose, I bestowed particular attention, in the month of November 1771, upon the Sea-Anemones. My first success in these discoveries soon turned these amusements of mine into a long study, much more laborious than that made in a library." Thus writes the venerable Abbé Dicquemare in the Philosophical Transactions for 1773, and doubtless there is many a naturalist of the present day who will sympathetically appreciate the sentiments he expresses.

Certainly among all the beauteous objects upon the sea-beach that woo our admiration, as though in emulation of each other's charms, none can bear comparison with the subject of the present chapter.

"The living flower that, rooted to the rock,
Late from the thinner element,
Shrunk down within its purple stem to sleep,
Now feels the water, and again
Awakening, blossoms out
All its green anther-necks."

We must, however, for the present, lay poetry aside, and, entering at once upon the practical part of our duties, proceed to give a few instructions relative to the best modes of procuring and preserving these roses of the Zoophyte creation.

On an excursion in search of Sea-Anemones, the sea-side naturalist will find it advisable to be provided with a double-headed hammer, a long iron chisel, an oyster-knife, an old ivory paper-knife, and a small net made by twisting a piece of strong wire into the shape of a circle with a tail to it, and fastening a bag of muslin round the edge of the ring. As to the hammer and chisel, these are indispensable. A great number of the Actiniæ delight in rock-holes, and it is impossible to get them out without chiseling away a portion of the rock to which they adhere. It is necessary, moreover, to be very careful in separating them from the rock; for, as a general rule, if they are at all lacerated, they mortify, corrupt the water in which they are placed, and finally die.

It is also desirable to be provided with a stout iron crow-bar, with which to turn over the large weed-covered angular rocks that lie at the verge of the ebb-tide—those stones which are never moved, even in the roughest weather, and under whose sure protection lie all the rarest and most delicate specimens*.

The difficulty of removing specimens from their native site is a great obstruction to the study of many, which the observer would select in preference. In

* *Vide* a Manual of Sea-Anemones commonly found on the English Coast, by the Rev. George Tugwell, Oriel College, Oxford. Van Voorst.

confinement, some will quit their hold, if left dry for a considerable time, or detach themselves, if the water be rendered very impure. But no effect is thus produced on many; nor does anything whatever induce them to move, or to abandon their fixture; they remain to perish. The only practicable mode of obtaining a coveted object under such circumstances, is, if possible, to chisel off a portion of the hard rock below it,—a tedious and precarious alternative, but one which nevertheless will often repay the naturalist for his trouble.

On finding a specimen which the collector may be anxious to preserve, it may be wrapped in moist sea-weed, or in a handkerchief wetted with sea-water, where it will be quite safe for many hours; and, if wanting a sufficient vessel for its deposition, he may first use a small saucer, which can be afterwards lodged in a larger vessel. A small quantity of water suffices for it, in case of necessity, wherein it may be kept uninjured for a long period in a vessel of very moderate capacity, but entirely covered by the element, or frequently washed with it. There is no difficulty either in feeding or preserving it, such is the variety of substances it devours.

The Actinia must be deemed a long-lived animal. A specimen of *Actinia mesembryanthemum*, whose portrait we reproduce (Pl. III. fig. 5), is figured by Sir J. Dalyell, which he had kept in a state of captivity for twenty years, and which could not have been under thirty years old; and another, apparently of equal age with the former when taken, had lived for thirteen or ourteen years in his possession; nevertheless, both

these patriarchal specimens were in full vigour, and likely to survive for years longer, at the time when Sir John recorded their longevity.

The Actinia is endowed with a very slow locomotive faculty; but this is rarely exercised, and then accomplished only by extending one edge of the base imperceptibly over the adjacent surface, and withdrawing the other; thus is a most languid and tardy kind of progression effected. But a specimen adhering to the open surface of the rocks will remain a long time stationary, only showing itself when incited to swell by the flowing tide, and again closing up as the sea recedes. Nevertheless, under certain circumstances, these creatures can detach themselves entirely from their station, and are then floated away to a new, and, perhaps, distant locality.

An Actinia in the possession of the late lamented Professor E. Forbes walked up the sides of a glass, by alternately adhering with its disc and base, in the leech fashion: he likewise observed that a Mediterranean species which is habitually free, swims by contractions in the manner of a Medusa—although, when confined in a glass, it attaches itself by its base just like a shore-Actinia.

Helpless as it generally seems to be, the Sea-Anemone is a powerful, fearless, and voracious creature. Having chosen a spot for firm adhesion, it spreads abroad its numerous tentacula to the utmost stretch in quest of prey. Nothing can escape their deadly touch. Every animated thing that comes in contact with them is instantly caught, retained, and mercilessly devoured. Neither strength nor size, nor

the resistance of the victim, can daunt the ravenous captor. It will readily grasp an animal, which, if endowed with similar strength, advantage, and resolution, could certainly rend its body asunder. It will endeavour to gorge itself with thrice the quantity of food that its most capacious stomach is capable of receiving. Nothing is refused, provided it be of animal substance.

All the varieties of the smaller fishes, the fiercest of the Crustacea, the most active Annelidans, and the soft tenants of shells among the Mollusca, all fall a prey to the Actinia. The flesh of terrestrial animals is also greedily swallowed; but this proves a less congenial aliment, for it is sometimes rejected.

The remarkable voracity of this creature warns the naturalist to beware of its presence among his collections, otherwise his most precious treasures will assuredly perish. Simple contact with the tentacula of the Actinia is enough to seal their doom; nay, some animals, as if conscious of their inevitable fate, seem paralysed by the touch, and yield without a struggle. Others, whose size and strength should ensure indemnity, are held in its relentless grasp, the Briarean arms crowding faster and faster around, until the victim is ultimately swallowed alive.

Dr. Johnston remarks, that he had once brought to him a specimen of *Actinia crassicornis*, that might have been originally two inches in diameter, and that had somehow contrived to swallow a valve of *Pecten maximus* of the size of an ordinary saucer. The shell, fixed within the stomach, was so placed as to divide it completely into two halves, so that the body, stretched

tensely over it, had become thin and flattened like a pancake. All communication between the inferior portion of the stomach and the mouth was of course prevented, yet, instead of emaciating and dying of an atrophy, the animal had availed itself of what undoubtedly had been a very untoward accident, to increase its enjoyments and chances of double fare. A new mouth, furnished with two rows of humerous tentacula, was opened up on what had been the base, and led to the under stomach;—the individual had indeed become a sort of Siamese twin, but with greater intimacy and extent in its union!

On the other hand, the Actinia is able to endure protracted fasting with impunity, plainly indicating the precariousness of its supplies; but under such circumstances the animal wastes away in a remarkable manner. In this condition the smallest portions of food prove restorative, and by abundance its dimensions are speedily enlarged and its strength renovated, so that it would seem never to have suffered from the prolonged starvation. Yet these creatures are capable of surviving one or two, perhaps three years, without further sustenance than the water can afford.

The whole exterior of the body in some species is endowed with a remarkable adhesive faculty, so that the skin is often covered by sand, or fragments of shells. The tentacula constantly retain everything that comes in contact with them. But this power of adhesion is the exercise of a peculiar faculty; it is optionally put in requisition, since substances are sometimes allowed to pass over, or to fall from, the

tentacula at will; nor is it at first obvious how adhesion, either there or to the rest of the body, is effected. Microscopic examination, however, shows this faculty to reside in a special prehensile apparatus, extensively distributed over the skin, consisting of innumerable capsules, which at the slightest touch appear to burst, and project long adhesive filaments, that stick to foreign bodies with as much pertinacity as burs to a lady's dress.

If one of these animals, when recently taken out of the water, be placed with the tentacula in contact with the human skin, and allowed to remain there for a few seconds, a smarting pain will sometimes be experienced, and the surface of the skin touched by the zoophyte will occasionally exhibit an inflammatory blush, speedily followed by a sort of nettle-rash, with a sense of burning and tingling, which will last for more than an hour.

A still more decisive method of appreciating this irritating power of the Actiniæ is, to bite one of the tentacula between the fore teeth, applying at the same time the extremity of the tongue to the part bitten: the sensation produced is almost precisely similar to that caused by biting, as schoolboys sometimes do, the acrimonious spadix of the *Arum maculatum*,—a taste something between that of a capsicum and that of a red-hot poker.

The senses of the Actinia seem to be extremely obtuse, and its perceptions alike obscure and imperfect. The creature neither seems sensible of the presence of its favourite prey even when in its immediate vicinity, nor does it resort to the quickest and easiest means

of preservation when it is itself in peril. The prey may be within a hair's breadth, yet it is seized only on actual contact. There is no spontaneous extension of the numerous tentacula, although they are capable of all kinds of inflexion, nor any apparent effort made to reach it. More singular still, should the vessel be gradually emptied, or the water evaporate, so as to leave the Actiniæ totally or partially dry, they will never move from their position in order to immerse themselves, not even when their tentacula can reach the surface.

The Actiniæ are very patient of injuries, and rival the Hydra in their reproductive powers. If the tentacula are clipped off, they soon begin to bud anew; and if again cut away, they grow again. Nay, more, it seems that "these reproductions might extend as far, or be as often repeated, as patience or curiosity would admit." If cut transversely through the middle, the lower portion of the body will, after a time, produce new tentacula, "pretty nearly as they were before the operation," while the upper portion swallows food as if nothing had happened—permitting it, indeed, at first to come out at the opposite end, "just as a man's head being cut off would let out at the neck the bit taken in at the mouth," but which it soon learns to retain and digest in a proper manner. In an experiment of this kind, the upper half, instead of healing up into a new basis, actually produced another mouth and tentacula, so that an animal was formed which caught its prey and fed at both ends at the same time. If, again, the section of the body is made in a perpendicular direction, so as almost to divide it into two

halves, these halves unite again in a few days. If the section be complete, two perfect animals is the result; and even if the body is torn away, and only a portion of the base remains, from this fragment a new offspring will sometimes rise up to occupy the place of its parent—at least so says Dicquemare*; and yet, according to the same authority, a wound or rent of the basis of an Actinia often proves fatal.

On November 9th, 1772, writes the Abbé Dicquemare, I clipped a brown Anemone (by a horizontal section) through the body; the basis, together with that part of the stump that was left to it, shrunk up and remained motionless, where it was attached till January 13th, when it shifted its place. On the 15th I very distinctly perceived two rows of limbs growing out of the part where the section was made, and the animal moved along. The next day I offered it bits of mussels, which it laid hold of and ate. These growing limbs were at first of a sullied white; they grew browner and browner every day, and are at present of the same colour as the coat of the animal. They are pretty near as large as they were before the operation, but I have not perceived as yet the beautiful blue globes which surround the disc of the perfect animal.

As to the part cut off, consisting of about half the body, and wherein the limbs and mouth are placed, I offered it, after the operation was performed, that brown part of a mussel, by the help of which it moves along, and whence the beard spreads out. This bit, which is not easily digested by Sea-Anemones, was at

* Dicquemare, Phil. Trans., Abridg. vols. xii. and xiv.

once snapped up by the arms. They drew it to the mouth, which lengthened itself out to catch it, and swallowed it down. But as the body was wanting that ought to have received it, the bit came out at the opposite end, just as a man's head, being cut off, would let out at the neck the morsel swallowed by the mouth. I still keep this part of the Anemone, which daily grows stronger and stronger.

In May 1772 I clipped off all the limbs (tentacles) of a purple Anemone. Soon after, these limbs began to bud out again. On the 30th of July they were clipped a second time, and grew again in less than a month. Having cut them a third time, they had a third shooting out.

Some people may be inclined, says Dicquemare, to accuse me of cruelty towards these creatures; but I think that, on taking into the account the results of my experiments, the animals ought rather to congratulate each other upon having been the subjects of them; for, not only have I succeeded in extending the duration of their lives, but have made them young again into the bargain, "ce qui n'est pas un petit avantage."

The propagation of the Actiniæ is not less remarkable than that of many of the preceding tribes of Zoophytes. We select, for the purpose of elucidating this part of their history, the *Actinia mesembryanthemum*, the subject of the observations of Sir John Dalyell, to whom science is indebted for pretty nearly all that is known concerning this portion of their economy.

The *Actinia mesembryanthemum* is always disposed to fix itself to the sides of its vessel, preserving the

body in a horizontal position. In this condition, while the tentacula are vigorously displayed, a number of dark substances may be occasionally seen in the tentacula, forming the lower half of the circle, but none are found in the distended tentacula of the upper half. The observer having counted ten, fifteen or twenty occupying the tentacula, may miss a portion of them, or even the whole, on returning to inspect them after a brief interval—all have disappeared—nor may he ever see them again. Under favourable circumstances, however, minute corpuscula, as well as larger and denser substances, are found in the distended tentacula, one or more in each, the corpuscula in motion, the others at rest. The latter are so many young Actiniæ in different stages of growth, some apparently so mature as to be ready for production, others in a less advanced condition. At first sight the observer will be disposed to class the animals before him with the numerous parasites infesting so many living creatures, and he may naturally enough look for them in the vessels containing Actiniæ. But his search will be in vain; for, unless on the rarest occasions, they are never seen at large. Instead of awaiting such an uncertain event, a more ready expedient can be resorted to, in amputating the *gravid* tentacula for the sake of obtaining their contents; and the appearance of these corpuscles, not being confined to any particular period of the year, allows greater scope for the experiment.

Sir John Dalyell, having inspected a distended tentaculum towards the end of October, severed it from the Actinia with sharp scissors, receiving the ten-

tacle and its contents in a watch-glass. Scarcely had it fallen there when a large embryo was discharged, and immediately afterwards two active corpuscula also escaped from the section; the former laid still; but the latter, of a reddish colour and globular figure, exhibited much activity in rotatory and progressive motion, describing an orbit, and revolving as if on an axis.

These corpuscula are the embryo Actiniæ in an early stage. Nothing can be so unlike the race: their form is such as almost to defy description.

All are red, opake, solid, some flattened, some elongated, some with irregular prominences, as if composed of two or more unequal spheres. Their motions are no less diversified, being evidently affected by considerable specific gravity, and regulated by cilia that surround their circumference, whatever be its outline.

A satisfactory view of the embryonic corpuscula may be obtained by amputating the tentacula; but they generally perish in a few days, whereby the purpose of lengthened observation is defeated. In order satisfactorily to trace their progress, it is necessary to wait for their escape from the body of the parent animal in a more natural manner.

This species of Actinia is viviparous. It produces its young alive through its mouth; and as the half-digested food is disgorged by the mouth—not without effort—we might presume that, in consequence, the young are sometimes disgorged with it. In fact, a specimen figured by Sir John Dalyell, having had a copious meal of an embryo skate, retained the food

twenty-four hours, when it was rejected, together with a numerous brood of thirty-eight young Actiniæ, some of them very large.

On a similar occurrence, rejecting the undigested food, a different specimen disgorged fourteen animated beings, after being ten months in confinement. Six of the fourteen proved to be corpuscula, like those above described; and these were carefully separated, committed to various vessels, and set apart for more attentive investigation.

They differed in nothing of importance from those extracted artificially from the tentacula: all were very minute, and they continued so for some time. Four were spherical; two consisted of two spheres united, exhibiting motions according to their form. Sometimes they reposed, sometimes they moved; their excursions were longer or shorter, though always laboured, as if the power of their natatory organs were inadequate to overcome the resistance.

The motion of these embryonic corpuscles continued eight days; but the shape of some was changing, and elongating prominences were rising on others. Their form improved, and it was evident that they would certainly become Actiniæ.

In ten days more the rudiments of tentacula became visible in the largest, and in other two days the tentacles were six in number; the movements of the rest had now relaxed, and they also exhibited obscure indications of tentacula; they resembled elongated caps with a convex base. Some were still devoid of any perceptible prominences; an internal organization could be discerned through the sides of others.

Nineteen days subsequent to production, eight or nine tentacula appeared on one which had fixed itself by the base, as did others shortly afterwards; their shape was cylindrical, with originating tentacula, irregular in number and dimensions—the largest having about twelve, the smallest about seven;—in short, the conversion of the corpuscle into a young Actinia was complete.

A remarkable deviation from the mode of propagation described above sometimes occurs among the zoophytes we are now considering, of which the *Actinia lacera* furnished Sir John Dalyell with an interesting example.

Whether, as in some other Actiniæ, the young be ever produced by the mouth, says Sir John, with characteristic caution, I cannot affirm. The observer, without ocular demonstration of the fact, might here be led into error; but during a large portion of the year, particularly in August and September, not perhaps excluding any month, the great irregularity of the base of adult individuals of the *Actinia lacera* cannot escape his notice; it is unequal and ragged to the eye, though all the other parts be regular, smooth and even.

This irregularity, at first hardly sensible, gradually increases until it becomes such as is delineated in the figure (Pl. III. fig. 6, *a*). Next, we behold diminutive fragments of the margin separating from the parent animal (Pl. III. fig. 6, *b*), which consist of the elements of embryo Actiniæ consolidated there, and soon to be developed into independent existence. So rapid is the progress of this development, that in a single

day two originating Actiniæ unfolded their external organs; and besides these, a multitude of fragments were advancing to perfection. Thus an uncommon mode of propagation is in this case effected by the spontaneous separation of fragments from the margin of the base of the parent Actinia, each containing the elements of its progeny, and by progressive evolution unfolding a new animal. This mode of reproduction is prolific: the specimen figured in our Plate produced twenty young ones in this way within a month, and as many more in three months; therefore probably at least seventy young ones were evolved and detached from this specimen in the course of the year. Nor is this remarkable mode of propagation confined to a solitary species.

An *Actinia dianthus*, in the vivarium of Mr. Jabez Hogg, became so firmly adherent to the side of the glass, that after having vainly endeavoured to detach itself, with an apparent degree of violence, it positively tore itself away, leaving behind six small pieces of the outer margin of its circular foot. Firmly glued to the side, these portions served for many days merely to mark the spot; at the end of a week, on attempting to clean them off with a piece of stick, Mr. Hogg saw, to his surprise, that they retracted on being touched; and in a few days more his surprise was still greater, to behold a row of tentacles growing around the upper part of each of them, and that they soon became every one of them developed into perfectly formed Actiniæ, the wounds of the parent animal being completely healed, and the creature quite as lively as before the occurrence.

Nothing, says Mr. Tugwell, is so grateful to the Actinia, so salubrious and invigorating, as frequent and abundant supplies of fresh sea-water. It is infinitely enfeebled, and at length the adhesive power becomes lost, by remaining in what is unchanged for months. But, although pining away to a tenth of its natural size, and remaining pertinaciously contracted by neglect, it speedily expands again on receiving a fresh supply from the sea, and gradually recovers its pristine beauty and vigour. The size and appearance of the Actinia may be therefore considered as absolutely dependent on the supply of renovated element, on sustenance and heat. In common with most soft-bodied animals, it contracts during cold weather, and expands under a genial temperature. Farther than this, there is no reason to admit its susceptibility of atmospherical or meteorological influence—far less, that it prognosticates changes to ensue.

The skin of these zoophytes is cast very often, especially after feeding greedily, as well as from continued abstinence. This exuviation extends in some species to the tentacula, the skin coming off from them in rings or belts. In the natural state, the Actinia is freed of the slough by the washing of the waves, but in confinement the body becomes encircled as with a girdle. This should be cut asunder with scissors, or brushed off by means of a feather, which will induce the expansion and promote the beauty of the specimen. All putrescent matter, or excess of food or rejecta of the Actiniæ, should be carefully removed, as the noxious gaseous compounds generated

by the decay of such matters appear to diffuse themselves rapidly through the water, act as a virulent poison, and speedily destroy the vitality of the occupants. Nevertheless, as there are exceptions to every rule, we are not surprised at finding some Anemones whose habits are by no means so refined. The *Actinia bellis* is a littoral species, and the commonest of its genus on the coast of Cornwall, where it is generally found in crevices in pools, the bottom of which is covered with Corallinæ and Nullipores. Yet it will sometimes forsake these "wells of pure water" for what is little better than a Stygian bog.

"March 14, 1846. This morning," writes Mr. Cox, "I visited the beach L. W. M."—(low-water mark, we presume)—"back of Mr. Sulley's hotel, Green Bank. It is composed of mud, sand, and decomposed algæ; many of the stones when lifted presented a face as black as the skin of an African, and sent forth a rich aroma of sulphuretted hydrogen. It is thickly studded with stones, varying from two ounces to thirty pounds. There are a few remnants of stunted rocks thinly scattered, from four to eight inches high; these are covered with *Fucus vesiculosus* and *serratus*. In turning the stones over, I was surprised to find in this Pandorian locality herds of the *Actinia bellis* in prime condition—jackets as red as a Kentish cherry—so pugnacious, that when touched, water issued in full streams from nearly all the tentacula; the ground is nearly covered with them," &c.

In some countries the Actinia is occasionally used as an article of food.

Speaking of the *Actinia crassicornis*, Dicquemare

says,—"Of all the kinds of Sea-Anemones, I would prefer this for the table; being boiled some time in sea-water, they acquire a firm and palatable consistence, and may be eaten with any kind of sauce. They are of an inviting appearance, of a light shivering texture, and of a soft white or reddish hue. Their smell is not unlike that of warm crab or lobster." Rondeletius, probably having the same *Actinia crassicornis* in view, tells us that it brings a good price at Bordeaux:—"ilz la lauent fort é souuent puis la fricassent legierement en la poele." *Actinia dianthus* also "is good to eat," according to Dicquemare; and Plancus directs the cook to dress this after the manner of dressing oysters, with which it is frequently eaten. Even the hot and peppery *Anthea* has its praise; from it they prepare the dish called *Rastegna*, which is a favourite in Provence.

CHAPTER XVII.

LUCERNARIA CAMPANULATA.

This beautiful zoophyte is about an inch in height, of a uniform liver-brown colour, and is usually found upon sea-weed near low-water mark, to which it adheres by a circular disc, above which there is a deep tricture or short peduncle. The disc or basis is strengthened internally by a delicate cartilaginous lamina. The margin of the oral expansion is somewhat thickened, and divided into eight equal arms, furnished with a tuft of numerous short tentacula, each of which terminates in a glandular extremity of a brighter colour than the rest of the body. The interior is hollowed like the blossom of a flower, and in the centre is a square, extensible, and projecting mouth, which opens into a loose, thin, plaited, extensible bag, constituting the stomach of this elegant production.

The Lucernaria is very hardy, and consequently not difficult to preserve alive; it is seen to be almost constantly in a state of expansion, and does not contract except when very rudely handled. Although generally found adherent to sea-weeds, the Lucernariæ can swim with some rapidity in the water by alternate dilatations and contractions of the body. When in a

state of expansion, they are sufficiently conspicuous from the beauty and singularity of form, but when contracted they are easily overlooked. They feed on small crustaceous animals brought within their reach by the tide or their own destiny, and, to arrest these more certainly, the tentacula are widely displayed; but no sooner do they feel their prey, than they instantly contract, envelope it in their joint embrace, and carry it to the mouth by an involution of the whole marginal circumference.

Their mode of progression, as we learn from Mr. R. Q. Couch, differs under different circumstances. If intending to move to any great distance, they do so by loosening their attachments, and then by various and active contortions they waft themselves away till they meet with some obstruction, where they rest, and if the situation suits them, they fix themselves; if not, they move on in the same manner to some other spot. If the journey be only for a short distance, as from one part of the leaf to another, they bend their bell-shaped rims, and bringing their tentacula in contact with the fucus, adhere to it by their assistance. The footstalk is then loosened, thrown forward, and twirled about till it meets with a place to suit it; it is then fixed, and the tentacula are disengaged; so that in this way the polyps move from one spot to another. Sometimes they walk about like the Actiniæ by a gliding movement of the stalk.

In taking their prey they remain fixed, with their tentacula expanded; and if any minute substance comes in contact with one of the tufts, that tuft contracts and is turned to the mouth, while the others remain expanded, watching for food.

CHAPTER XVIII.

ENCRINITES—COMATULA.

THE contemplative mind need never be in want either of instruction or amusement, if it will only condescend to read the records of the past, so legibly inscribed on the imperishable pages of creation, and moreover will find the handwriting upon the rocky walls which everywhere surround us by no means difficult of interpretation. They possess, indeed, a wonderful advantage over the most enduring legends of what we call antiquity; they are written for all time, and in a language equally intelligible to all the sons and daughters of Adam. No lexicons are here required, for the Almighty himself is his own interpreter.

To any of our readers who thus, like ourselves, are fond of finding sermons in stones, we heartily recommend a marble chimney-piece as a preacher of matchless eloquence and most convincing argument; nay, more (and that quite independently of the fire which usually warms such discourses), a most enlivening and cheerful companion. It is true that all marble chimney-pieces are not equally communicative and conversationable: that, however, is common to all sorts of society. Our friend and special fire-side companion is *that* chimney-piece of Encrinitic limestone hewn from some mountain-side in Derbyshire;

every inch of it inscribed with hieroglyphics far more readable than those of Egypt, far more beautiful than sculpture or mosaic could have made them.

The history it speaks of stretches back through countless ages, and relates to scenes that passed away before antiquity began: its every fragment is a monument whereon we read I AM.

The polished surface of the marble shows that its whole substance is composed of animal remains, the jointed stems of creatures that in shape somewhat resembled plants and flowers, and hence are named "stone lilies," "lily-stones," and "lily-encrinites." It is indeed difficult, from a smooth section of such marble, to make out precisely what have been the forms of these elaborate structures—still more difficult by any industry to extricate them from the stony matrix in which they lie imbedded; so that we might have still remained in ignorance as to their real conformation had not an unexpected agent come to the assistance of the naturalist, and performed this labour for him—

"Quid magis est saxo durum—quid mollius unda?
Dura tamen molli saxa cavantur aqua."

Water is soft, and marble hard; but yet
We see soft water through hard marble eat.

and the surface of the weather-beaten cliffs, dissected, as it were, by the continual peltings of the pitiless storm, display, in the shape of "screw-stones," countless myriads of these exhumed relics.

We may judge, says Dr. Buckland, of the extent to which these Encrinites multiplied among the first

inhabitants of the sea, from the countless myriads of their petrified remains, which fill so many limestone-beds, and compose vast strata of marble, extending over large tracts of country both in Northern Europe and in North America. The substance of this marble is almost as entirely made up of the petrified remains of Encrinites, as a corn-rick is composed of straws. Man applies it to construct his palace and adorn his sepulchre; but there are few who know, and fewer still who duly appreciate, the surprising fact, that much of this marble is composed of the skeletons of millions of organized beings once endowed with life and susceptible of enjoyment, which, after performing for a time the part that was assigned to them in living nature, have contributed their remains towards the composition of the mountain masses of the earth.

Thanks to the unwearied labours of geologists, there is no longer any doubt concerning the real nature of these admirably constructed organisms.

The stem of the Encrinite was formed of innumerable joints, piled upon each other like the masonry of a slender Gothic pillar. The name of *Entrochi*, or wheel-stones, has with much propriety been applied to these insulated joints, and the perforations in the centre of each affording a facility for stringing them as beads, caused them in ancient times to be used as rosaries. In the northern parts of England, indeed, they still retain the appellation of "St. Cuthbert's beads":

> "On a rock by Landisfarn
> St. Cuthbert sits, and toils to frame
> The sea-born beads that bear his name."

Each of these individual pieces, observes Dr. Buckland, presents a similar series of articulations, varying in minute particulars as we ascend upwards through the body of the animal, so that every joint is exactly adjusted to give the requisite amount of flexibility and strength. From one extremity of the series to the other, and throughout all the rays and pinnules of the flower-like head, the surface of each joint articulates with that adjacent to it with the most perfect regularity and nicety of adjustment. So exact and methodical is this arrangement, even to the extremity of the minutest tentacula, that it is just as improbable that the metals which compose the wheels of a chronometer should for themselves have calculated and arranged the form and number of the teeth of each respective wheel, and that these wheels should have placed themselves in the precise position fitted to attain the end resulting from the combined action of them all, as for the successive hundreds and thousands of little pieces that compose an Encrinite to have arranged themselves in a position subservient to the end produced by the combined effect of their united mechanism; each acting its peculiar part in harmonious subordination to the rest, and all conjointly producing a result which no single series of them, acting separately, could possibly have effected.

The physiological history of the family of Encrinites is very important: their species were numerous among the most ancient orders of created beings, and in this early state their construction exhibits at least an equal, if not a higher degree of perfection, than is retained in the existing Pentacrinites; and

although the place which, as zoophytes, they occupied in the animal kingdom was low, yet they were constructed with a perfect adaptation to that low estate; and in this primæval perfection they afford another example at variance with the doctrine of the progression of animal life from simple rudiments through a series of gradually improving and more perfect forms to its fullest development in existing species.

The multiplicity of parts entering into the composition of the framework of one of these now almost extinct productions would indeed be incredible had we not ocular demonstration of the fact in every geological cabinet.

Mr. Parkinson states that, after a careful examination, he has ascertained that, independently of the number of pieces in the stem, and which from its length are undoubtedly very numerous, the fossil skeleton of the flower-like head of the Lily-encrinite (*Encrinites moniliformis*) consists of at least 26,000 pieces; and if we were to take into the account the minute calcareous plates interwoven with the integument covering the abdominal cavity, and spreading over the inner surface of the rays and pinnules, this number must be surprisingly increased; and yet even this unheard-of multiplication is simplicity itself when compared to what is met with in other species now lying before us.

The number of joints in the arms and tentacula of the fossil Briarean Pentacrinite (*Pentacrinus Briareus*) amounts to at least a hundred thousand; and if to these we add fifty thousand more for the ossicula of the side arms, which is much too little, the total

number of pieces will exceed a hundred and fifty thousand. Now, as each joint was furnished with at least two fasciculi of fibres, one for contraction, the other for expansion, we have a hundred and fifty thousand bones and three hundred thousand fasciculi of fibres equivalent to muscles in the body of a single Pentacrinite,—an amount of muscular apparatus concerned in regulating the movements of the skeleton infinitely exceeding any that has been yet observed throughout the entire animal creation.

When we consider, continues Dr. Buckland, the profusion of care and exquisite contrivance that pervades the frame of every individual of this species of Pentacrinite—forming but one of many members of the almost extinct family of the Crinoideans,—and when we add to this the amount of analogous mechanisms that characterize the other genera and species of this curious family, we are almost lost in astonishment at the microscopic attention that has been paid to the welfare of creatures holding so low a place among the inhabitants of the ancient deep, and we feel an irresistible conviction of the universal presence and eternal agency of creative care in the lower regions of organic life.

As the base or root of the ancient Pentacrinite (*Pentacrinus Briareus*) was undoubtedly fixed to the bottom of the sea, or to some extraneous floating substance, the flexibility of the jointed column which forms the stem was subservient to the double office, first of varying in every direction the position of the body and arms in search of food, and secondly, of yielding with facility to the course of the current, or

fury of the storm, swinging like a vessel held by her cable with equal ease in all directions around her moorings.

The root of the Briarean Pentacrinite, Dr. Buckland thinks, was probably slight, and capable of being withdrawn from its attachments; and the further fact of its being frequently found in contact with masses of drifted wood, now converted into jet, led him to infer that the Briarean Pentacrinus was a locomotive animal, having the power of attaching itself temporarily either to extraneous floating bodies, or to rocks at the bottom of the sea, either by its side arms, or by a moveable articulated small root*.

In the year 1823 Mr. J. V. Thompson discovered in the bay of Cork a singular little pedunculated animal, which he called *Pentacrinus Europæus*, which immediately gave rise to much interesting discussion both at home and abroad, for it was the first animal

* The beautiful specimen of this Pentacrinus, figured by Dr. Buckland, and taken from the Lias at Lyme Regis, adheres laterally to a portion of imperfect jet, which forms part of a thin bed of Lignite, or fossilized wood, met with in the Lias marl between Lyme and Charmouth. Throughout nearly its whole extent, Miss Anning has constantly observed in this lignite the following curious appearances. The lower surface *only* is covered by a stratum entirely composed of Pentacrinites, and varying from one to three inches in thickness: they lie nearly in a horizontal position, with the foot-stalks uppermost next to the lignite. The greater number of these Pentacrinites are preserved in such a high state of perfection, that they must have been buried in the clay that now invests them before decomposition of their bodies had taken place. It is not uncommon to find large slabs several feet long, whose *lower*

of the Encrinite kind which had been seen in the seas of Europe, and the first recent Encrinite that had ever been examined by a competent observer in the living state.

The history of this creature, says Professor Forbes, is one of those little romances in which Natural History abounds; one of those narrations which, while believing, we almost doubt, and yet, while doubting, we must believe—it being the only crinoid animal at present inhabiting our seas, at one time so full of those beautiful and wonderful creatures, and consequently presenting points of great interest, not to the zoologist only, but to the geologist.

"Such is the rarity of living Encrinites, that many years elapsed from the first discovery of the fossil Crinoidea before any living species presented itself; and during the last half-century, although Natural History and Geology have been pursued with zeal and ardour, and with advantages too heretofore un-

surface only presents the arms and fingers of these fossil animals expanded, like plants in a *hortus siccus*; while the *upper* surface exhibits only a congeries of stems in contact with the under surface of the lignite. The greater number of these stems are usually parallel to one another, as if drifted in the same direction by the current in which they floated.

The mode in which these animal remains are thus collected immediately *beneath* the lignite and never on its upper surface, seems to show that the creatures had attached themselves in large groups (like modern barnacles) to the masses of floating wood, which, together with them, were suddenly buried in the mud, whose accumulation gave origin to the marl wherein this curious compound stratum of animal and vegetable remains is imbedded.—*Buckland's Bridgewater Treatise.*

known, not above half a dozen in the whole have found their way to Europe: of these, one is in the National Museum at Paris, from Martinique; one in the British Museum, taken off Nevis; one in the Hunterian Museum in the Glasgow College, from Barbadoes; one in the Museum of the Royal College of Surgeons in London; and one in that of the Geological Society.

The West Indian species (*Pentacrinus Caput Medusæ*), and that described by Mr. Thompson, are, in fact, the only existing species hitherto discovered; the first of these is an animal of considerable size, its jointed stem thicker than a swan's quill, rising to the height of several feet, and the spread of its arms being equal to a span*. The latter, on the contrary, is probably the smallest of the tribe, not exceeding, when full-grown, three-quarters of an inch in height, and slender in proportion; and doubtless it was owing to this minute size that it so long escaped the prying eyes of the most industrious naturalists.

The pedicle or stem of this little zoophyte is not thicker than a piece of sewing-silk, being but slightly enlarged towards its upper end. It is composed of a variable number of joints (about twenty-four in full-grown specimens), which are shorter as they approach its upper part, until, immediately adjoining the body,

* The dimensions of the largest recent *Pentacrinus Caput Medusæ* are very humble when compared with some of their fossil congeners. We have before us at the present moment some dozens of specimens from the limestone rocks of Derbyshire, whose stems measure at least an inch in diameter, and which when complete were perhaps ten or twelve feet high.

they present the appearance of mere rings or plates; so that it is probably here that successive articulations are formed, which add to the increasing length of the stem as the animal advances in its growth.

The exterior of the stem, as well as of the pieces composing the body and rays, is invested by a continuous delicate membrane which binds them together, and furnishes the requisite support to the muscular system, which their motions lead us to suppose they must necessarily possess, and which is probably no other than what presents itself under the appearance of a gelatinous translucent substance interposed between this membrane and the ossicula. The animal possesses the power of bending or inclining the stem freely in every direction, and, what is more remarkable, of twisting it up in a short spiral, and that with a considerable degree of vivacity.

The arms or rays surrounding the flower-like body are five in number, but at the second joint each of them divides into two, so as to represent a star with ten rays. These branches or divisions of the arms are each composed of a single series of solid calcareous joints, about twenty-four in number, diminishing gradually in thickness from their origin upwards; at either side they are fringed with soft tentacula, which are jointed, and capable of considerable contraction and extension. These tentacula, which are moved in every direction, arise from the opposite sides of the rays in an alternate order, and when highly magnified appear to be themselves furnished with cilia, placed alternately along their sides. It is these arms, composed of numerous joints, and fringed with tentacula,

that give to the Crinoidea such a beautiful appearance; at one time spreading outwards like the petals of a flower, at another rolled inwards over the mouth of the animal like an unexpanded bud. From their structure and movements, it can hardly be doubted that they serve to seize upon and convey to the mouth whatever has been destined for its food, and which probably consists of every minute animal its powers enable it to overcome.

The body, situated in the centre of the rays, presents a central opening or mouth, formed by five petal-like valves, which possess the power of expanding or of folding down closely, so as to shut up the mouth; within these valves, when expanded, several soft tentacula present themselves, similar in structure to the tentacula of the arms. The most remarkable part of its structure, however, consists in the existence of a *distinct* termination to the alimentary canal, which, perforating the side of the body, ends in a tubular opening of considerable size, and capable of a remarkable degree of elongation, being at times as conspicuous in this respect as at others it is difficult to discern. This unlooked-for peculiarity, quite different from what is met with in the generality of starfishes, subsequently led to the detection of a similar arrangement in the genus *Comatula*,—a discovery, the importance of which the reader will immediately appreciate.

The smallest specimens of Pentacrinus observed by Mr. Thompson did not exceed one eighth of an inch in height. In this stage the animal resembles a little club, fixed by an expanded basis, and giving exit at

its apex to a few pellucid tentacula: no other part of the solid fabric is as yet observable. In specimens that have made a little more progress, together with the elongation of the pedicle or stem, its joints begin to make their appearance; the body acquires a larger size and brownish tint from a grosser food; the tentacula of the mouth protrude in a greater degree, and move slowly in various directions. In others still more advanced, the joints of the stem become quite obvious from their opacity and white colour, and the base of the future arms, as well as the auxiliary side arms, are rendered palpable. The arms from this period lengthen apace from their bifurcation, and have superadded to them a double range of transparent jointed tentacula; so that the animal begins to put on a more perfect appearance, and now for some time merely acquires a somewhat greater size and an extension of its arms, which, although they solidify from their origin upwards, remain pellucid and thick at their apices, where elongation, evolution, and the secretion of calcareous matter are gradually going on. Here, then, we have the form, the structure, and the mode of growth of the Encrinite exemplified before us, and can see with our own eyes what, until the discovery of this little animal—doubtless common enough on our own coast—remained involved in impenetrable mystery, viz. the nature, habits and attributes of the millions of extinct Crinoideans whose remains constitute our limestone cliffs and encrinitic marbles.

But the interest which attaches itself to the grow-

ing *Pentacrinus* by no means terminates here; it has yet another history, which we must proceed to develope, and which, embracing, as it does, one of the most remarkable discoveries in modern Zoology, claims our notice.

If we were told by any traveller, that he had visited an unknown region where the animals dropped their eggs on trees and shrubs, and that the eggs there fixed themselves, and shot up, like parasitic plants, with a long stem, gradually evolving at their extreme end limb after limb and function after function, until the young animals thus formed became so perfect as to resemble their parents in every essential point, and that then their attachment with the connecting foot-stalk was dissolved, that they became locomotive, and betook themselves to the free and wandering life of the parent stock, few could be got to believe facts so incredible, and so much at variance with the usual course of nature.

It is no uncommon thing, in the inferior classes of the animal kingdom, to find animals permanently attached from the period of their birth and during the whole of their existence. Familiar examples of this occur in the Oyster and various other bivalve shell-fish, as well as in numerous compound Zoophytes. We shall in the following pages likewise meet with races which are free and locomotive in their first stages, and afterwards become permanently fixed; but an animal growing for a period in the similitude of a flower on its stem, and then dropping from its pedicel, and becoming during the remainder of its

life free and peripatetic, is not only new, but without any parallel in the whole range of the organized creation.

When therefore Mr. J. V. Thompson first described the *Pentacrinus Europæus,* no person could have suspected so anomalous and unexpected a result, as that it was the young state of a Star-fish, the *Comatula*, an animal easily procurable upon many parts of our coast; and to the structure of which we must next turn our attention.

The body of the *Comatula* (Pl. III. fig. 9) consists of a small, circular, flattish disc, from the circumference of which issue ten long pinnate rays, the expanse of which, in a full-grown specimen, is at least five inches, measuring from tip to tip of the opposite extremities.

The dorsal surface of the disc is provided with ten or twelve slender organs, each terminated by a claw, which from their action and use may be described as claspers, as it is by means of these that the animal fixes itself to foreign substances.

The Comatula is, in fact, a star-fish, not only free, but leading the most vagrant life of any of its tribe; at one time crawling about by means of its flexible arms among submarine plants, at others floating to and fro, adhering to their fragments by means of its dorsal claspers, or even swimming about after the manner of the Acalephæ. In swimming, indeed, the movements of the arms of the Comatulæ exactly resemble the alternating stroke given by the Medusæ to the water, and has the same effect, causing the animal to rise from the bottom and to advance back-

foremost with considerable rapidity. Upon their under surface the rays of the Comatula are furnished with multitudes of vibratile cilia, which by their action produce strong currents in the water, and hurry along towards the mouth whatever floating particles may happen to be in the vicinity, thus continually affording an abundant supply of food.

The evidence of Pentacrinus being the young of Comatula rests upon a comparison of the most advanced state of the former with the youngest Comatula procured by dredging. In the adult Pentacrinus it will be observed, that the arms are just beginning to form pinnæ or lateral leaflets towards their extremities, that they have a sulphur-yellow colour and dark marginal spots. In the very young Comatula these pinnæ are but slightly further advanced, and others may be observed sprouting in a manner precisely similar. Individuals a little older are comparatively common, in which the pinnæ are complete; and from this period they appear to be formed regularly at the base of the arm, as this goes on extending in length. These small Comatulæ, moreover, still retain the original sulphur-yellow colour towards the apices of the arms, while the lower part and body gradually assume the rosy hue characteristic of the adult animal.

From observations repeatedly made, Mr. J. V. Thompson thinks it probable that the young Comatulæ attain their full growth in one year, so as to be in a condition to propagate their kind in the summer following that of their birth.

In May and June the full-grown Comatulæ may be

found, having the membranous expansions inside each of the pinnæ considerably extended, at least as far as the fifteenth or twentieth pair; these, called *conceptacula*, at length show themselves distended with ova, which in July, and even earlier, make their exit through a round aperture on the side of each conceptaculum, still however adhering together in a roundish cluster, consisting of about a hundred eggs. By what means these ova are dispersed, or how they become attached to the stems and branches of corallines, remains to be discovered; but it is strongly to be suspected that the animal is gifted with the power of placing them in appropriate situations, otherwise we should find them on fuci, shells, stones and other foreign bodies, which does not appear to be the case*.

However this may be, the ovum from which the Pentacrinus is developed is first met with in the form of a flattened oval disc, by which it is permanently fixed to the point selected, and giving origin to an obscurely jointed stem that ends in a club-shaped head (Pl. III. fig. 8), whereon may be observed the incipient formation of the arms and the mouth with its tentacula. At *d* in the same figure is another, somewhat more advanced, in which the jointings of the arms become more obvious; whilst at *c*, the head of the Pentacrinus, completely formed, is ready to separate from the stem that supports it, and thus become a detached and roving Comatula.

* The stalked young are not found only on corallines, as Mr. J. V. Thompson supposed. Mr. W. Thompson finds them on the leaves of Fuci, and remarks that they are very active animals on their pedicles.—*Forbes's British Star-fishes.*

The Comatula, like other Star-fishes, is liable to fall to pieces in the aquarium. Indeed this is the way in which they all seem to perish. Part after part drops off, until only the naked disc remains, the water becoming slightly tinged by their decay.

CHAPTER XIX.

ASTEROPHYTON—THE SHETLAND ARGUS.

"The heavens declare the glory of God, and the firmament sheweth his handy-work."

WHO is there that can read these words of the Psalmist without joining in the glorious pæan? Who is there that does not appreciate, to some extent at least, their solemn import? To acknowledge, however, the general truth of such a proposition, and adequately to feel its import, are two very different things; and the appreciation of the sublimity of expression used by the inspired writer must always be in exact proportion with our ability to trace the scope of his meaning.

It is an easy matter for a child to sing about

"The spacious firmament on high,
And all the blue ethereal sky,"

without having much conception of the real nature of

"Those argent fields above,"

among which the genius of a Herschel is lost in wonder and admiration. It is the astronomer only, —whose powerful telescope, and still more far-seeing calculations, enable him to fathom the blue profound, and there to contemplate the amazing spectacle;—

"To see where system into system runs,
Where other planets circle other suns;"

—who feelingly, but, even then, inadequately, can understand the value of the words and the truthfulness of their import.

It is easy for any one to acknowledge in general terms the power of the Creator, and to allow that His providence is over all His works; but it is the microscopist only, who, by reversing the Galilean tube, is enabled to explore nature in the opposite direction,—to penetrate beyond our unassisted vision, and survey the worlds contained within the boundaries of a drop of water, can tell how deeply that Providence extends, how awful that Almighty power, who "spake and it was done, who commanded and it stood fast."

If the heavens have their stars, so has the sea. "Non cœlo tantum sed et mari suæ stellæ sunt, opera quidem unius Dei artificis sed diversæ prorsus fabricæ et naturæ. Cœlestes ubique locorum vulgus conspicit, marinas ne physicorum quidem omnes intuentur."

The *Asterophyton*, or *Shetland Argus*, called also the *Medusa's head* (Pl. III. fig. 10), is occasionally met with on our northern coasts. "As he swims," says Grew*, "he spreads and stretches out all his branches to their full length, and, as soon as he perceives his prey within his reach, he hooks them all in, and takes it, as it were, in a net,"—a description which perhaps some of our readers may think to be rather too quaint and laconic for an animal so strange and so remarkable, and upon which we shall, we hope, be pardoned if we amplify a little. Or perhaps the following account,

* *Vide* Account of the Museum of the Royal Society.

written almost a century ago, will best answer our purpose. We like the graphic eloquence of a first description; it comes smacking off the lips, true and racy; there is no retailing it at second-hand, and no chance of foisting off a copy for the genuine portrait. It would be as easy to retail a pun, or carry a kiss into the next room on a salver, as to attempt to imitate the enthusiasm of an original describer.

"I understand by the fisherman who brought me this fish, that he never saw nor heard of any but six or seven that were taken by himself not far from the shoals of Nantucket, when he was fishing for cod. This Stellar-fish, when it was alive, and first pulled out of the water, was like a basket, and had gathered itself round like a wicker-basket, having taken fast hold upon the bait, which he had sunk down to the bottom to catch other fish, and, having hold of that with its arms, would not let it go, though drawn up into the boat, until, by lying a while on the deck, it felt the want of its natural element, and then voluntarily it extended itself into a flat, round form. The only use that could be discerned of all that curious composure with which Nature has adorned it, seems to be to make it as a purse-net to catch other fishes, or any other thing fit for its food, and as a basket of store to keep some of it for its future supply.

"He told me that every one of its smallest parts, when it was alive, had motion and tenacious strength; but after it was dead, and extended to a flat round, it was so brittle that it could not be handled without breaking some parts of it; but by carefully hanging it to dry, it was somewhat hardened. I think, till a

fitter English name can be found for it, that it may be called a *Basket-fish*, or a *Purse-net-fish*. This elaborate piece of nature we may call *Piscis Echino-stellaris visciformis*; its body resembling an Echinus or Egg-fish—the main branches a star—and the dividing of the branches the plant Misseltoe. It spreads itself from a pentagonal root into five main limbs or branches, each of which, just at the issuing out from the body, subdivides itself into two; and each of the ten branches thus formed does again divide into two parts, making twenty lesser branches; and each of these doth again divide into two smaller branches, making in all forty; these again divide into 80, and those into 160, and they again into 320. The division is again repeated, making 640; afterwards 1280, 2560, 5120, 10,240, 20,480, 40,960; and at the fourteenth division, beyond which the farther expansion could not be certainly traced, there were 81,920 small tendrils or threads, in which the branches of this star-fish terminate."

The shell of the *Asterophyton*, which is harder than that of the Echinus, is entirely covered with a thick fleshy envelope. From the circumference of the disc proceed five strong rays, each of which soon divides into two secondary trunks, and these, subdividing again and again, always by binary division, soon become multiplied into innumerable branches, which, like living ropes, spread out all around the body of the animal. Every one of these rays is made up of an immense number of jointed pieces, so that they are as flexible as whip-cord, and as manageable as the legs of a spider; and each of these innumerable

cords is in the living animal terminated by a minute yellowish fleshy ball something resembling a little foot; so that the whole creature, as it walks along, resembles a conglomeration of serpents strangely linked together, whence it has, not inappropriately, received its mythological cognomen of *Gorgonocephalus*.

These Star-fishes inhabit the deep parts of the sea, and seem principally to frequent coral-beds, and localities where marine plants are abundant, around the stems of which they intertwine their arms, and climb about in search of sustenance.

It is rather difficult to imagine that so many thousand pieces, so precise in form, and so artistically conjoined, managed to put themselves together of their own accord, without the counsel of superior wisdom;—to become distributed thus widely, without an agency more powerful than their own. And yet these wonderful organisms have been repeated again and again, age after age, in countless multitudes.

Surely the Epicurean fool or atheist, who would prate about the fortuitous concourse of atoms, or even more modern dreamers about genera and species formed by chance, had better look again at one of these despised "Sea-baskets."

CHAPTER XX.

OPHIURUS—PLATE-MAIL STAR-FISH.

We remember, some years ago, strolling into the parrot-house in the gardens of the Zoological Society, in a very quiet and inoffensive manner as we thought, certainly without the remotest idea of giving umbrage to any of its pretty feathered occupants, when, to our great surprise, our entrance seemed to be the signal for a wild and general disturbance—the sound of the tocsin could not have roused an insurrection more uproarious than that produced by the appearance of our (pardon us, gentle reader, if we flatter ourselves) by no means repulsive physiognomy; dire was the screaming, fierce the gesticulation of every scansorial biped among them. Parrots, macaws, and cockatoos seemed equally indignant at our intrusion; and such a clamour as they raised, such a whirlwind of discordant sounds, would certainly have done credit to Babel. Overwhelmed with the noise, deafened with the horrible cacophony, we beat a retreat, and right gladly escaped into the quiet glades of the gardens.

On our return, after the lapse of an hour or so, finding that all was tranquil within, we again entered the parrot-house, and again were greeted with a

concert, beating marrow-bones and cleavers, and all rough music imaginable.

Wondering what could be the cause of a reception so uncourteous, where before we had always been a welcome visitor, we approached an old favourite cockatoo, and, reproachfully holding up a little walking-cane before her face, began to expostulate with her upon such behaviour. We could scarcely have imagined the picture of rage and terror that the bird presented: with crest erected to the uttermost, staring eyes, and limbs trembling all over, she retreated to the extreme limits of her chain, and struck with her wings at my cane, as if fighting for very life; —and so indeed she was, or thought she was, for, on my attention being thus directed to my little cane, I appreciated at once the cause of her fury—the head of the walking-stick was carved in imitation of that of a serpent, with brilliant eyes, and a most grim and threatening aspect. the supposed appearance of so terrible a foe amongst their peaceful party had, by an instinct true and natural, roused them to self-defence, affording at once a proof of the carver's skill who had so ornamented my rattan, and an illustration of instinctive horror of a very interesting character.

But we can by no means say it was with the same feelings of admiration that we, on a subsequent occasion, witnessed an exhibition of sham terror upon a somewhat similar pretence. Net in hand, we were climbing over the scars, and making our way among the slippery sea-weeds in search of specimens for the aquarium of a friend, when we happened to light upon an *Ophiurus*, a very fine little fellow, full of life and

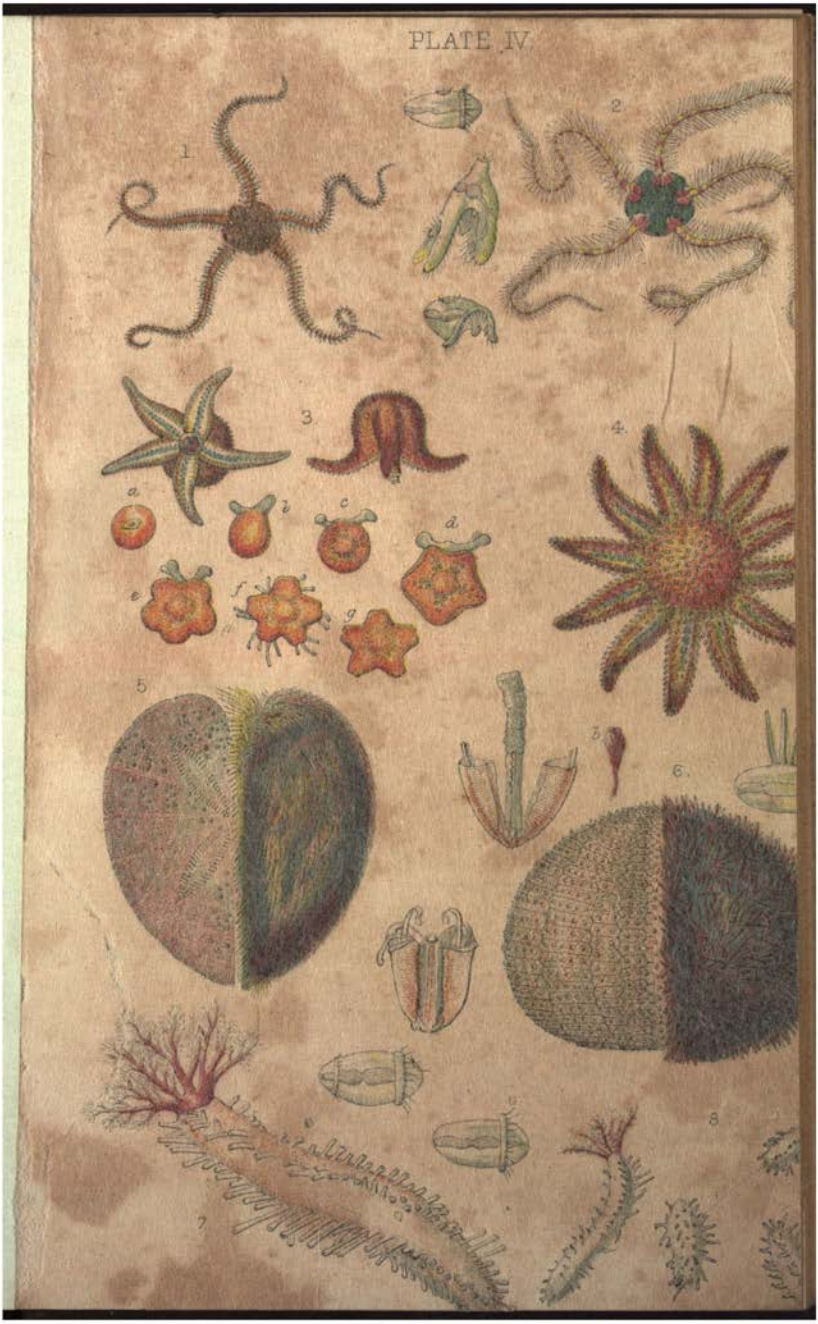
vigour, which we hastened to offer to the inspection of some ladies, our companions upon the beach. Judge of our mortification, when, instead of expressing the slightest interest or curiosity upon the occasion, they began to scream and shriek very much after the same fashion as the cockatoos, interlarding their screams every now and then with—Oh, the horrid thing! What is it? Will it bite?—until at length one of them, more valorous than the rest, stamping upon my poor *Ophiurus*, liberated her friends from their assumed fear, and with the air of a second Judith after despatching another Holofernes, stood triumphing in the act.

The Ophiurus in question is, it need hardly be said, a star-fish, in shape somewhat resembling the impress upon a Manx halfpenny—only, instead of three legs surrounding nothing, and the motto *Quocunque jeceris stabit*, it consists apparently of five serpents' tails implanted around a central disc, and is quite unable to stand at all.

This very elegant animal (Pl. IV. fig. 1) is to be met with on almost every coast; and from the varieties that it presents, it is somewhat perplexing to say what shall be assumed as the type of the species. Some are remarkably beautiful on account of the profusion and distribution of the colours wherewith they are decorated, yellow, blue, green and red being agreeably interspersed in a single specimen, so as to render them at once both showy and interesting occupants of the vivarium.

The *Ophiuri* are characterized by having a central disc, from the circumference of which proceed five

PLATE IV



slender rays, which, both in their general appearance and in their movements, strikingly remind the spectator of the tail of a serpent, from which circumstance these creatures have in fact derived their scientific designation (*ὄφις, a serpent; οὖρος, a tail*).

The disc is circular or sub-angular, and the mouth, which is situated in the centre of the under surface, pentagonal and very dilatable. The upper surface is in some species nearly smooth, in others clothed with very minute scales or spines; but its chief variety is in colour, and in the distribution of the colours, some of them being exceedingly beautiful.

Instead of the elaborate apparatus of suckers specially serving for the movements and adhesion of the *Asterias,* the rays of the *Ophiurus* consist of jointed segments, and are provided with an infinity of spiny processes arranged along their sides, which, together with their accessory parts, are very different in different species. The rays also are covered by scales, which present great diversity of form, arrangement, and distribution.

The rays of the *Ophiuri* are extremely liable to mutilation, partly owing to their length and slenderness, and partly because they so easily become entangled among foreign substances; they are, however, speedily renewed, although the reproductive faculties seem less energetic in these creatures than in some of the preceding races of Star-fish.

The vigour and the dimensions of the Ophiurus seem to depend very much on the places where it dwells, and the facility of obtaining subsistence. Some live in deep water; multitudes are met with

on oyster-beds, and some frequent the sand nearer to the shore. On the whole they are extremely numerous, and from the vast multitudes continually destroyed, their race would seem to be inexhaustible.

Some of the *Ophiuri* will feed voraciously on the flesh of the mussel, which they seem to prefer to the oyster, although the latter is by no means rejected; nay, sometimes, so voracious is their appetite, that, after a full meal, the centre of their disc may be observed stuffed out like a cushion by repletion. They have not, however, been observed to swallow the shells of bivalves, although their mouth is susceptible of considerable dilatation, and the capacity of the stomach sufficient for their reception; but whenever a part of the flesh of the mussel is within reach, the extremity of one of the rays is soon twined around it, and it is carried to the mouth and greedily devoured. However ravenous at times, they will occasionally pass many days without food.

Mutilation is inevitably concomitant on impurity of the water; but without any obvious cause we witness it continually, and that to the most destructive extent. Piece by piece falls off from the rays, until nothing but the disc remains, and yet the animal still lives. After a specimen had been preserved some time, only a very short fragment of the rays continued entire; still the animal fed greedily, nor was motion utterly extinct even when the disc itself was partly decomposed.

Early in April, the disc is seen remarkably full, plump and round in the margin—the space intermediate between the rays being occupied by spawn,

and on separating a portion of the under surface, the eggs, of a vivid red, are seen adherent to it. The colour is so bright, that the under surface of the disc is sensibly affected, and the space between the rays occupied by the spawn becomes ruddy. The spawn is composed of ovoidal capsules confusedly huddled together.

But the most interesting part of the history of the *Ophiuri* is the wonderful metamorphosis through which they have to pass, during their progress from the egg to their mature condition.

The young *Ophiurus* on leaving the egg presents itself under a most grotesque aspect, in which condition it has long been known to naturalists, and described under the name of the *Pluteus paradoxus*, or Easel-animalcule, from its resemblance to a painter's easel, without however the slightest idea being entertained of its ultimate destiny.

The *Pluteus paradoxus* (Pl. IV. fig. 1, *a*, *b*, *c*) is exceedingly minute, being not more than $\frac{2}{5}$ths of *a* line in length. When highly magnified, its body is seen to have somewhat of a conical shape, terminating above in a point, but dividing inferiorly into eight long processes or appendages of various dimensions, to which it owes its peculiar figure. Each of these processes is supported by an internal calcareous framework, which, branching in different directions, forms a basis whereon the soft parts are spread out.

The whole animal is perfectly transparent, its substance resembling dull glass—the apex of the body and the extremities of the arms or processes being slightly tinged with orange.

These singularly formed *larvæ* (for such they are) are to be found abundantly during the months of August and September, sometimes crowding the surface of the sea in rich profusion, swimming freely about by the aid of rows of cilia, with which their arms and the apex of their bodies are plentifully furnished.

The first appearance that presents itself indicating the commencement of metamorphosis, is the development of a number of projections around the stomach of the *Pluteus*, which soon increase so much in number that they form a series of rows surrounding the stomachal cavity. At first these projections do not extend beyond the body of the *Pluteus*, remaining, as it were, concealed beneath its disc; but soon acquiring greater development, they make their appearance externally, and begin to assume some regularity of arrangement, in which the rudimentary form of the future star-fish begins to be perceptible, and the points whence the arms are to proceed become apparent.

In carrying out this part of the proceeding, it will be observed that the original arms or processes of the *Pluteus* have had no share. The *Pluteus*, in fact, stands just in the same relation to the young *Ophiurus* as the frame does to a piece of embroidery. Neither has the structure of its arms anything in common with that of the rays of the future star-fish, which lies, as it were, protected by their shelter.

In the condition which it has now attained, the young *Ophiurus* is much smaller than the rest of the *Pluteus*; but as its growth increases from this point,

the body and processes of the latter assume more and more the appearance of being only appendages to the newly developed animal, until by degrees they entirely disappear, the only part of the *Pluteus* remaining as a part of the *Ophiurus* being the stomach. Before, however, the arms of the *Pluteus* have entirely disappeared, the feet or retractile suckers have begun to show themselves arranged in a circle around the circumference of the shield-like disc, so that it is able to creep about freely in the sea.

Shortly before the disappearance of the last remnants of the *Pluteus*, the arms or rays of the *Ophiurus* are already visible, projecting prominently from the margin of the shield, but consisting as yet only of the outer or terminal joint of the future ray; the moveable spines likewise gradually show themselves, and the characters of the future star-fish begin to be recognizable. Ultimately new segments are slowly added to the rays, making their appearance between the first-formed segment and the margin of the disc. The places where all new segments are formed are in the shield itself, and each successive segment being formed at the base of the ray, is of course, owing to the progressive growth of the animal, larger than all that preceded it.

Such is the remarkable mode in which the *Ophiurus* is promoted from its egg condition to its perfect state, after witnessing which, the reader will scarcely be surprised at anything which he may encounter in the way of transmutations of form among the lower animals.

The Brittle-stars (*Ophiocoma*, Pl. IV. fig. 2) are

much more active animals than the Ophiuri, which in many respects they closely resemble. They seldom remain quiet for a moment, but are continually twisting about their arms; and, if laid hold of, they break into little pieces with wonderful facility, each fragment of an arm also breaking itself up into smaller pieces; indeed, frequently, when we seize one of these creatures, we find nothing but the disc remaining.

CHAPTER XXI.

ASTERIAS—THE CROSS-FISH.

"Non cœlo tantum, sed et mari suæ stellæ sunt, opera quidem unius Dei artificis, sed diversæ prorsus fabricæ et naturæ. Cœlestes ubique locorum vulgus conspicit, marinas ne physicorum quidem omnes intuentur."—LINCKIUS.

AMONGST the most interesting decorative and characteristic occupants of the marine vivarium must be enumerated the various species of Star-fishes properly so called, constituting the great genus *Asterias* of modern zoology,—a race of animals so beautiful in colour, so elegant in shape, so wonderful in structure, and so peculiar in their habits, that they are at once ornamental and instructive.

The Star-fishes, as a race, may emphatically be designated marine animals. There is nothing at all resembling them to be met with throughout the fresh waters of the globe; they stand unique and aloof from all other creatures; while, from the complexity of their organization and their inexplicable attributes, they defy alike the skill of the anatomist and the acuteness of physiological research.

And yet, who would suppose, at the first aspect

of one of these creatures lying helpless upon the beach—

"Like the corpse of an outcast abandon'd to weather"—

that there was anything attractive about it? Who would dream, on seeing them heaped in cartloads and carried off for manure, as we have sometimes done, that they possessed a delicacy of sense and a perfection of movement almost unparalleled in creation? We must examine these Star-fishes under more favourable circumstances if we would appreciate them properly.

The *Asterias* is provided with long rays, which issue immediately from the parts round the mouth, for there is no definite central disc, although the body is thick and compact; the rays, indeed, may be said rather to fork from each other than to issue from a centre. They are stout and taper, convex above and flattened beneath, terminating by many slender suckers at their extremities; besides which, there is a channel in the under surface, with rows of suckers, stronger, more numerous, and of larger dimensions, serving as feet, both in progression and for fixture.

The Northern Sea-star, the species most common upon some of our coasts, is among the largest, the most powerful and ravenous of its kind, sometimes measuring, when completely expanded, twelve inches between the tips of the opposite rays. The colour is extremely variable, but usually purplish or greyish. Purple seems to be the natural colour, although when very young it is met with cream-coloured, or even white.

When inactive, the animal is greatly contracted, crouching closely in some cavity, as if for concealment, or occupying a corner of the tank, apparently quite helpless and incapable of resistance. When roused, however, by heat or hunger, it advances as if half-swimming, with a quickness such as could scarcely be ascribed to its nature, its rays extended, and the numerous suckers in action. It never really swims, nor does it spontaneously leave the water, though frequently met with left behind by the receding tide.

No creature is more rapacious. Its prey is devoured alive whenever it can be overpowered. Let a moderate-sized mussel be presented, and it is straightway covered by the body of the Star-fish, while, the rays closing around it, the animal sustains itself on them as on feet, contracting more and more as the food is gradually swallowed. If the portion of food be too large for the mouth, the stomach begins to protrude, and is applied around it. In this way shell-fishes, whether univalves or bivalves, become an easy prey: the Turbo and the Pholas fall victims alike. As the prey is brought under the mouth, it is hemmed in on all sides by the rays, and either crushed asunder or swallowed entire: small fishes, small Echini, and even some of its own race, are all sacrificed to its merciless voracity.

Though much exceeding the specific gravity of the water, Star-fishes of various kinds are capable of a swift, gliding motion, as if nearly buoyant—a circumstance that may be accounted for by a quantity of the surrounding element being absorbed into their inte-

rior, whereby the bulk of these creatures is considerably increased, and their specific gravity consequently diminished in the same proportion.

However firmly a Star-fish may be adherent by means of its suckers to a foreign body, its hold is immediately loosed on depriving it of the surrounding water, so that if any of the vessels containing them be emptied, they soon fall from the sides to the bottom. In this way, without using the slightest violence, which is always productive of injury, the animals are brought under the readiest control, for when deprived of their native element they are helpless.

In their natural state, these Star-fishes are disposed to crawl into fissures in the rocks for protection during the ebb of the tide, or they creep underneath stones or into shells, anywhere where a little water may chance to be retained.

The fishermen of some districts entertain an inveterate antipathy to the Star-fishes, from a rooted belief that they are particularly destructive to oysters. They find them, they say, in the very fact—actually within the shells devouring the contents;—an accusation leading to indiscriminate vengeance against the imagined offenders. The ancients indeed tell us dreadful tales concerning the destruction of oysters by these rapacious gormandizers, and nevertheless their truth still remains problematical, for certainly it is by no means evident at first sight how the alleged warfare can be carried on, or how the inhabitants of such large shells can be either reached or extracted. Sir John Dalyell seems inclined to question the reality of such a proceeding, arguing, that though the fisher-

men assert that they have seen the enemy *flagrante delicto*, they are by no means either close or accurate observers.

"I have not heard it suggested," says Sir John, "that the Star-fish possesses any kind of solvent compelling the bivalves to sunder. Neither can its hostility be very deadly to the larger univalves, from the distance to which they are enabled to retreat within their portable dwellings. Their general habits are, to force the shells of smaller bivalves asunder, and to devour the contents; they likewise consume the substance of ordinary fishes entire; nevertheless, as far as I am yet aware, their destruction of oysters is destitute of evidence. The Star-fish sometimes shows an eversion of the stomach, or of some membrane resembling it. Whether this may be the means of affecting their prey merits investigation."

In this latter suggestion, Sir John Dalyell has very nearly hit upon the true solution of the problem. There are more ways than one even of eating an oyster, and the method adopted by the Asterias is peculiar. It is quite evident, from the small size and undilatable structure of the mouth of the Star-fish, that it can never introduce an oyster, shells and all, into its stomach, more especially as the edible mollusk is always firmly fixed upon its bed; but that is no reason why it should not put its stomach into the oyster, and thus effect its purpose in a different manner. Its mode of proceeding is as follows:—Grasping its shell-clad prey between its rays, and firmly fixing it by means of its prehensile suckers, it proceeds deliberately to turn its stomach inside out,

embracing in its ample folds the helpless bivalve, and perhaps at the same time instilling some torpifying fluid; for the shells of the poor victim seized soon open, and it then becomes an easy prey.

All the race of Star-fishes are extremely subject to mutilation of their rays; of their full complement, many have four, others three, two, and some only one remaining. Such mutilation does not appear to be incident either to size or age, but takes place alike in old and in young specimens, and, what is more, it is in both equally succeeded by complete reproduction of the lost parts.

On the 10th of June a single ray was picked up by Sir John Dalyell, which had either separated from an entire specimen or was the residue of one that had lost all the other parts. It showed no symptoms of reproduction at the time, but, on the 15th, the rudiments of four additional rays were indicated by four nipple-like prominences projecting about the sixteenth of an inch from the broader end. Next evening one of these had acquired nearly double the size; the others were less advanced; but a small orifice—a new mouth—was forming in the centre of the group: the work of reproduction now proceeded vigorously, and, after two or three days longer, the animal again consisted of five rays, four of which were of pigmy dimensions when compared with their giant associate. After the lapse of another month, the original ray fell to pieces, leaving the newly formed body surrounded only by the four newly developed rays. This was a singular accident, as by it the animal became once more symmetrical and *all* young again; nothing

remained disproportionate or offensive to the eye, and the renovated Star-fish entered vigorously upon its new career.

From the aversion of the fishermen to all sorts of star-fish, both large and small, they were formerly wont to rend them asunder, and commit their lacerated bodies to the waves—with what result the reader can easily imagine. It is said that they are now grown wiser, and on discovering their purpose to be defeated by the extraordinary reproductive energies of their victims, are content to cast them on the shore, and leave them there to perish. Certainly their old plan of tearing every Cross-fish they got hold of into two or three pieces, each capable of regenerating all its missing parts, was anything but a way to diminish their numbers.

And here, methinks, the reader will expect us to write a vehement philippic against such wanton destruction of Star-fishes, and such a puerile display of impotent vengeance on the part of the fishermen: assuredly our pen, ever ready in defence of the persecuted victims of ignorance, was just preparing itself for the task, but—will it be credited?—we really sympathize with the fisherman, and scarcely have the heart to censure a man for losing his temper, *at last*, after patiently enduring reiterated insult and provocation;—yes, it would have tried the patience of Job to have been plagued as those poor fishermen are by the ubiquitous "five fingers" or "devil fingers," as some of them are pleased to call them. It is not about the oysters that fishermen trouble themselves —that is a mere excuse—it is a downright personal

quarrel with the Star-fishes themselves, and *certes* they have some cause for the animosity they bear these quinquefid nuisances.

It is our invariable practice when at the sea-side—that is, in fine weather—to catch our own breakfast; —we make it a point of conscience;—whiting, delicious fresh-caught whiting!—plain butter—shrimp-sauce! Shade of Apicius!—but we must keep to our text.

Now, it is our opinion, that a man who is fishing for his own breakfast has an interest in success, second only to that of the poor fisherman who fishes for his livelihood, and must almost equally feel the pangs of disappointment in case of failure. Let us fancy ourselves therefore seated in our boat, and, after a glorious pull just half a mile out to sea, preparing for the sport:—the laughing water, sparkling in the morning sun, dances around us as we cast the heavy stone —our anchor—amidst the gently swelling waves, and, eager for the sport, prepare our lines:—we feel a tugging at our hook, and, hauling up the lengthened string, expect a prize; when, lo! 'tis but a villainous star-fish that has seized our bait, gorging it deep and fast. Again we try, and with the same result. Bait after bait is thus devoured, till you begin to think that shoals of cross-fishes are waiting there on purpose to annoy you. Let me see the man, hungry and tired, with every prospect of being breakfastless to boot, who keeps his temper under such a trial!

But, however inimical to the fisherman, the Star-fishes must always be regarded by the naturalist with unmitigated wonder, and their importance in the

grand œconomy of Creation at once acknowledged. Their appetite is for carrion. Their restless and unceasing industry is constantly employed in hunting out and swallowing all dead, all tainted matters that approach the shore, which, if permitted to accumulate, would soon pollute the very ocean, and convert the wave-washed beach into a charnel-house, defile the air, and render earth itself an uninhabitable waste. All silently and quietly the work is done by these unwearying agents. Cleanliness and health attend their gentle footsteps; while, to crown the whole, each, like a living granary, pours forth innumerable eggs, and thus supplies abundant food for countless hungry and expectant mouths, peopling the sea with life, and adding to the already boundless store of Nature's provender.

The natural enemies of the *Asterias* are innumerable as the hungry maws of cod-fishes, and many others of the larger and more rapacious tenants of the deep abundantly testify; nay, cannibal-like—as the aquariist will doubtless soon discover to his cost—certain races do not spare each other.

Most species of Star-fish, if taken strong and vigorous from the sea, are sufficiently hardy to be easily preserved in the vivarium of the practical naturalist, and with due precaution will survive a long time. Several species feed copiously and grow rapidly, some of them attaining dimensions which seem extraordinary. They are very impatient of heat, whence it is necessary to keep them in a cool place; and frequent renovation of the water is absolutely indispensable during hot weather.

In confinement these creatures are almost invariably subject to frightful mutilations. Not only do they lose large portions of their body, or even entire rays, but the whole animal sometimes literally falls to pieces; nay, although to-day you may possess a complete and beautiful specimen, which has behaved itself in a manner perfectly correct and satisfactory, there is no saying but that to-morrow morning you will find nothing left of it but a heap of fragments dispersed through the water. This kind of suicide is a casualty apparently incidental to the whole race, and with some species, amongst which *Luidia fragilissima* stands pre-eminently conspicuous, it is so generally put in practice, and that upon the slightest occasions, that to procure one in an entire state is almost impossible.

Prof. E. Forbes, often baffled by this suicidal habit, upon one occasion was induced to take special precautions against it; he accordingly provided a bucket of fresh water to receive and kill instantaneously any that might be caught by the dredge, and a very amusing account he gives of the ill-success of the experiment. "As I expected, a *Luidia* came up—a gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sank my bucket to a level with the dredge's mouth, and proceeded, in the most gentle manner, to introduce *Luidia* to the purer element. Whether the cold element was too much for him, or the sight of the bucket too terrific, I know not, but in a moment he proceeded to dissolve his corporation, and at every mesh of the dredge his frag-

ments were seen escaping. In despair I grasped the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision*."

We are reminded by the concluding sentence of the preceding facetious quotation, that, in order to explain the allusion made by our late lamented friend to the "terminating eye and spinous eyelid" of the Star-fish, it will be necessary to say a few words concerning the senses of these extraordinarily gifted creatures. That they do perceive what is going on in the world around them, at least in so far as their own business is concerned, there cannot exist a doubt; nay, that their perceptions are acute and rapid, any one who has witnessed the facility with which they find and devour a bait, or a morsel of food, will readily allow; but how they are enabled to effect this is by no means so easily explained. That it must be by some sense analogous either to smell or vision, seems pretty evident; but where we are to look for their noses or eyes is a problem not of very easy solution. In many species, however, there are found, situated at the extremity of each ray, certain bright red spots, very conspicuous in the living animal, around which the terminal spines cluster, as though for their protection. These red spots are by many eminent naturalists regarded as the eyes of the Star-fish, and the surrounding spines constitute the eyelid above alluded to. How far they are or are not instruments of vision, is a matter still open to dispute, and a question well worthy of solution by any of our

* Forbes, British Star-fishes.

readers, whose opportunities enable them to make experiments upon this interesting subject.

The eggs of the Star-fish come to perfection in the months of April and May, at which time the roe, which consists of large bundles of tubes occupying the angles between the rays, is very much distended. The eggs indeed are incredibly numerous, so that all surprise at the multitudes of these creatures met with upon our coast at once ceases on beholding their prodigious fertility. When first deposited, the ova are not at once abandoned by the parent animals, but are retained in a kind of cavity formed by incurving the body and rays of the mother, until they make a sort of chamber, beneath which the eggs are protected during the earlier part of their development (Pl. IV. fig. 3). The young animal, at the moment of its escape from the egg, is of an ovoid or subspherical shape (Pl. IV. fig. 3, *a*), completely unprovided with limbs, but enabled to swim vivaciously about in the surrounding water by means of the cilia with which its body is profusely covered, giving it exactly the appearance of an infusorial animalcule;—indeed this may be called the first, or infusorial condition of the young Asterias. After the lapse of a few days, certain appendages begin to make their appearance, sprouting, as it were, from the anterior part of the body, and ultimately appearing as forming four club-shaped processes, whereby the little creature fixes itself to the sides of the incubatory cavity (Pl. IV. fig. 3 *b*, *c*, *d*, *e*). The body of the little embryo now becomes gradually flattened into a minute circular disc, upon one surface of which—hence at once distinguished as the ventral—the rudiments of

suckers begin to be apparent under the form of globular protuberances, disposed in ten concentric rows (Pl. IV. fig. 3, *d*, *f*). If in this condition the little being is detached from the spot where it has fixed itself, it is still able to swim about in the surrounding water by means of its ciliated surface, always keeping the organs of attachment directed forwards; but if left undisturbed, it remains perfectly still and motionless, presenting what M. Sars calls the *crinoid* state of development, considering that in this condition it corresponds to the state of the fixed *Encrinite*. At this stage, the body of the young Star-fish may still be said to be bilateral; for in all its movements the organs of attachment are directed forwards, and both sides of the body correspond exactly to each other; but by degrees this bilateral condition is converted into the radiated form that characterizes the third or perfect state of the Asterias; the body begins to assume a pentagonal outline, from the angles of which, short, blunt rays begin to project (Pl. IV. fig. 3, *g*), and the tentacula, now presenting the form of retractile cylinders, and completely furnished with their terminal suckers, become efficient instruments of locomotion. The red spots, regarded as the eyes, are visible at the extremities of the nascent rays; the mouth shows itself in the centre of the ventral aspect of the body, and numerous spines make their appearance. Lastly, the apparatus for attachment begins to diminish in size, and soon completely disappears; so that the young Asterias, having attained its perfect form, is ready to enter upon the duties of its station.

CHAPTER XXII.

ECHINUS—SEA-URCHIN.

THE subjects of the present chapter are popularly known by the name of Sea-urchins, or Sea-hedgehogs, from the circumstance of their shells being covered with moveable prickles, like the skins of those quadrupeds; but when the prickles have fallen off, the shells are more commonly called Sea-eggs, partly from a conformity in figure between the objects compared, and more so from a similarity in their calcareous composition and texture. From their forms, certain genera have been called *turbans, diadems, mermaid's skulls,* or *hearts,* or *fairy stones*; a nomenclature doubtless more pleasing to our readers than the Greek compounds of science, and not less poetical than useful, since they aptly convey a portraiture of those varieties of form into which Nature has, with her usual sportiveness, moulded these productions.

Few objects in the animal creation are better calculated to impress the mind of the student of Nature with feelings of reverential awe towards the Divine Artificer, than one of these, at first sight despicable animals. Consider them from whatever point of view we choose, the elegance of their shapes, the elaborate

complexity of their structure, the diversity of their forms, their incalculable numbers in existing races, the still more innumerable series of extinct genera, or the wonderful attributes with which they are individually endowed, they will always furnish materials for interesting contemplation.

How shall we commence our description of an Echinus? We have heard of the journals of continental tourists, in which it is gravely chronicled, that "in this princely collection of pictures there is a Guido measuring 3 ft. by 3 ft. 5." We have heard the Thames Tunnel described as having required so many millions of bricks for its construction. We have heard the mosaics in St. Peter's admired on account of the innumerable pieces of various-coloured stones required for the composition of those perdurable monuments—but we cannot say that we were much enlightened by such connoisseurship. Let the reader examine for himself with due attention one of these wondrously constructed beings, and then pronounce whether among the works of man he has ever seen anything more mathematical in design or more artificial in execution.

The shell of an *Echinus esculentus* of moderate size is composed of at least ten thousand distinct pieces, so accurately conjoined that the whole fabric seems a single shell. Upon the exterior of this amazingly constructed dome may be reckoned not fewer than three thousand spines of various sizes, all capable of independent movement. Add to these at least a thousand tubular sucking-discs, instinct with life and motion, not to mention innumerable appendages which

stud the exterior of the body, and we have indeed a microcosm alike worthy the contemplation of the philosopher and the admiration of the student. Surely, exclaims an old writer, the hand that made a Sea-urchin was well able to build up a world!

The calcareous plates entering into the composition of this extraordinary shell may be divided into two distinct sets, which differ materially in size as well as in the uses to which they are subservient. The larger pieces are recognizable by hemispherical tubercles of considerable size attached to their external surface, adapted, as we shall afterwards see, to articulate with the moveable locomotive spines. Each of these larger plates has somewhat of a pentagonal form; those which are situated in the neighbourhood of the mouth and of the opposite aperture being considerably the smallest, and every succeeding plate becoming progressively larger as they approximate the central portion of the shell. The entire series of pieces in each row resembles in figure the shape of the space included between two of the lines which mark the degrees of longitude on a terrestrial globe, broad at the equator, but gradually narrowing as it approaches the poles; an arrangement of course rendered necessary by the spherical form of the creature.

The reader must not, however, conclude that the large central tubercles above mentioned are the only parts of the shell to which spines are affixed; hundreds of similar elevations are disseminated over the surface, to which smaller spiculæ are appended, although, from their diminutive size, these are of secondary importance in locomotion.

It is impossible, by any verbal description at all commensurate with our present undertaking, adequately to explain the more minute contrivances visible in the disposition of every portion of these wonderfully constructed coverings. It is sufficient for our present purpose to observe, that the globular crust of an Echinus is made up of several hundred polygonal pieces of different sizes, and, although presenting every variety of outline, generally approximating more or less to a pentagonal form;—that these pieces are so accurately and completely fitted to each other, that the lines which unite them can scarcely be distinguished, even upon the most minute examination; and that from the union of so many distinct and dissimilar plates results a firm, compact and beautiful box, the shell of the "Sea-Egg."

The first question that naturally suggests itself on examining a shell of this description, is concerning the object to be attained by such remarkable complexity. It would appear, at first sight, that a simple calcareous crust, like the integument of a lobster, had it been allowed to exude from the entire surface of the Echinus, would gradually have moulded itself upon the body of the creature, and thus have formed a globular shell, composed of but a single piece, but answering every purpose connected either with support or defence.

A very little investigation, however, will serve to show the necessity for the elaborate arrangement here exhibited. In the first place, the earthy matter is not deposited upon the surface of the body, but within the soft external integument by which it is

secreted, the interior of the shell being filled with sea-water, in which the viscera are loosely suspended.

But a second and more important reason for the employment of so many pieces in the construction of this wonderful fabric is to be derived from examining the mode in which the animal grows. Were it to retain the same dimensions throughout the whole period of its life, or could it at stated intervals cast off its old investment and secrete a new and more capacious covering as growth rendered the change necessary, a simple earthy crust would have been sufficient, without the presence of such an immense number of joinings and sutures. The calcareous plates of the Echinus, it must be remembered, are merely secreted from the soft parts, having no vital action going on within them, whereby, as in the bones forming the skeletons of the higher animals, a continued deposition of fresh particles could be effected, allowing of extension by interstitial deposit. How therefore is the gradual expansion of the entire shell, thus composed of a dense, dead crust, to be effected, and that without ever deranging the proportions of the whole fabric or necessitating a loosening of its parts? No other contrivance could apparently have been adequate to the purpose; nevertheless, by the structure adopted, we see how admirably the growth of the Echinus proceeds in all directions; for the living and vascular membrane which covers the whole external surface of the body, and dips down between the edges of the various calcareous pieces, continually deposits around the margin of each individual plate successive layers of earthy particles, which, assuming

a semicrystalline arrangement, progressively increase its dimensions. But the continual augmentation in size which is thus going on simultaneously in all parts, is attended with no change in the mathematical figure of any given piece of the shell, so that the whole fabric gradually expands without in any degree altering its form or relative proportions, until it has acquired the mature dimensions belonging to its species.

If we remove the spines of a young specimen recently dead, we shall then observe, that amongst the plates situated near the opposite orifices of the shell and the plates that bear spines, there are some less fully developed, irregular in form, and taking their place amongst the perfectly formed plates only in proportion as they gradually attain to a larger size. In that region of the body where this increase takes place, the membrane which unites all the plates, and spreads itself over their surface, is softer and more spongy than it is in those parts where the plates are consolidated and immoveable. It is, in fact, this spongy mass that deposits the calcareous matter of which the plates are composed, and the spines shoot out in the centre, almost in the same manner as the horns of a stag. They do not become moveable until they have attained a certain degree of development, and there is a period in their growth after which their size does not increase. Those, moreover, which drop off accidentally are replaced by others, formed as the preceding ones had been, by the membrane which covers the plates. We may always indeed observe in a single specimen all the gradations of increase, from that of

the plates which have completed their growth and bear fully formed spines, down to the smallest commencement of plates as yet unfurnished with spines.

Passing from pole to pole of the globular shell, the reader will next observe ten rows of plates, disposed in pairs, *avenues* as they are fancifully called; these are at once recognizable by innumerable minute perforations, the *ambulacral orifices*, disposed with great regularity. The ambulacral orifices in the living Echinus give passage to numerous tentacular-looking organs, each of which is terminated by a minute sucker, and endowed with a truly wonderful power of contraction and extension; insomuch that when unemployed they are retracted, something like the horns of a snail, until they quite disappear; but when actively employed, they are protruded until their sucker-like extremities reach beyond the points of the longest spines, and thus are enabled to lay hold on foreign objects.

The number of these suckers is very great. In a moderate sized Sea-urchin Professor Forbes reckoned sixty-two rows of pores in each of the ten avenues. Now, as there are three pairs of pores in each row, their number multiplied by six, and again by ten, would give the great number of 3720 pores; but, as each sucker occupies a pair of pores, the number of suckers would be half that amount, or 1860. Imagine therefore the complicated mechanism wielded by one of these animals even for the simple purpose of taking a walk.

In order to understand the manner in which the Sea-urchin employs these remarkable organs, let us

suppose a specimen at rest. All the suckers are retracted within, or close to, the shell, and the spine remains motionless. A few of the suckers now protrude; they search around for a solid foundation; others follow them, until at length many of these adhesive discs are at work, and the animal is fixed securely by their assistance. Should the Echinus wish to change its place, the suckers behind are seen to relax their hold, while the contraction of others in front brings forward the shell. The suckers therefore in this case are the principal instruments of progression, wherein they are but feebly aided by the spines, and thus the creature advances in its course with surprising expedition. If a portion of food be now dropped into the vessel, the Echinus speedily becomes sensible of its presence. Should the creature be above, the suckers are soon seen to be put into active requisition, and its descent commences immediately as it hastens to the repast.

The most striking feature in the construction of the Sea-urchin, from which indeed the animal derives its name, is found in the prickles or spines which stud the exterior of its shelly box, and which form a very important part of its locomotive machinery. Each of these spines is in fact a kind of leg, articulated to the exterior of the shell by a beautifully constructed ball-and-socket joint, and moved by a special apparatus; so that by means of these numerous legs the creature is enabled to roll itself about upon the beach, or, if danger threaten, to bury itself in the sand, and thus escape from observation. This latter feat the Echini are in the habit of putting in practice

whenever, having wandered too far, they are left behind by the retreating tide; still, however, it is not impossible for the practised eye to detect their place of concealment, which is recognizable by a kind of funnel-shaped depression observable in the surface of the sand immediately over their retreat. The fishermen even pretend to judge of the probability of a storm by the urchin burying itself more or less deeply beneath the surface.

The Sea-urchins are stated to be carnivorous, and are said to feed upon crustaceous and bivalve mollusca. How far this may be true it is difficult to say; their stomachs—and we have examined numbers of them—are generally found filled with nothing but the debris of Algæ, Zoophytes, Desmideæ and similar materials. M. Bosc, however, states positively, that he has seen one eating a crab which it had seized with its tentacular suckers, and was busily employed in breaking up by means of its formidable teeth.

According to the account of another writer,—"The Sea-urchin is a most voracious and promiscuous feeder, always ready to eat; nor is any animal better qualified for the destruction of others with impunity to itself. The strength of the teeth is marvellous; and, as if to prove auxiliary, the principal power for the capture of prey seems to reside in the suckers near the mouth. The Echinus is, in fact, a bold, fierce, and destructive creature, the inveterate enemy of whatever it can overcome, and greedily devouring all that comes in its way, even what seems secure from assault. Nothing has any chance of escape; fish, flesh, Zoophytes, Algæ and Fuci, all are accepted;

and it will even make a hearty meal of pure shell. An Echinus of moderate size having seized a small living crab, the victim seemed to be paralysed by simple contact; nor did it offer any resistance to its ferocious foe. Another Echinus, not more than fifteen lines in diameter, fastened its extended suckers on a small lobster, a *Galathea*; but the latter, fortunately for itself, directing one of its claws with sufficient dexterity, cut the suckers asunder, and thus freed itself from its assailant's deadly grasp. Indeed, these animals seem to have a natural propensity to destroy. Specimens not a quarter of an inch in diameter will tear sea-weeds into fragments."

Cavolini assures us that the Echini live upon sea-weeds. Dr. Monro, on the contrary, tells us that they live upon living shell-fish, which they seize and secure by means of their suctorial ambulacral tubes. "I therefore directed the fishermen to bring me along with the Echini some living Buccina, to which, as I supposed they would do, they attached themselves so effectually, that when I lifted the Echinus out of the water, I found it could support with ease a Buccinum which weighed nearly a quarter of a pound"—rather an odd proof of the nature of their diet certainly; for the same might be said of them with respect to any stone of similar weight with which they may happen to be brought in contact.

"The Echinidans," says Mr. Kirby, "whose station appears to be often near the shore upon submerged ledges of rocks, feed upon whatever animal they can seize. We have seen that they sometimes turn upon their back and sides, as well as move horizontally.

This enables them more readily to secure their food with the aid of the numerous suckers in the vicinity of their mouth, which, when once they are fixed, never let go their hold till the animal is brought within the action of their powerful jaws."

We really should be glad if some of our readers could throw a little light upon this part of the economy of the Sea-urchins; it is a very interesting subject for investigation.

The jaws of the Echinus, indeed, are as curiously formed as any other part of their structure. Their mouth is a simple orifice through which the points of five sharp teeth are seen to protrude. These teeth obviously perform the duty of incisors, and from their sharpness and extreme density are well calculated to break the hard substances said to be employed as food. The points of such incisor teeth, although of enamel-like hardness, would nevertheless be speedily worn away by the constant attrition to which they are necessarily subjected, were there not some provision made to ensure their perpetual renewal: like the incisor teeth of rodent quadrupeds, they are therefore continually growing up behind as fast as they are worn away in front, and are thus always preserved sharp and fit for use. In order to allow of such an arrangement, as well as to provide for the movements of the teeth, jaws are provided, which are situated in the interior of the shell, and these jaws, from their great complexity and unique structure, form perhaps the most admirable masticating instrument met with in the animal kingdom. The entire apparatus, removed from the shell, consists of the following parts.

There are five long teeth, each of which is enclosed in a triangular bony piece (fig. 6 *c*, *d*), that, for the sake of brevity, we will call jaws. The five jaws are united together by various muscles, so as to form a pentagonal pyramid, having its apex in contact with the oral orifice of the shell; while its base is connected with several bony levers by means of numerous muscles provided for the movements of the whole. When the five jaws are fixed together in their natural position, they form a five-sided conical mass, aptly enough compared by Aristotle to a lantern, and frequently described by modern writers under the name of the "lantern of Aristotle." The whole of this complicated machinery is suspended by muscles from a framework fixed in the interior of the shell, and may often be picked up upon the beach, or, still better, exposed *in situ* in a dead Echinus, by those who would examine closely this wonderful piece of mechanism.

The *Echini*, in the structure of their ovarian apparatus, exhibit, if possible, greater simplicity of arrangement than even the Star-fishes described in a preceding chapter. The ovaria are five delicate membranous bags, quite distinct from each other, which open externally by as many delicate tubes, or oviducts, as we may term them. The apertures through which the eggs escape are easily seen upon the outer surface of the shell, placed around the opening opposite to that of the mouth, and are at once recognizable, not merely by their size, but from the circumstance of each perforation being situated in a distinct oval plate of the shell, distinguished by zoological writers as the

ovarian pieces. The membranous sacs in which the ova are secreted vary in size in proportion to the maturity of the eggs contained within them, and at certain times of the year are enormously distended. It is in this state that the "roe of the Sea-egg," as the ovaria are commonly called, is used as an article of food, and in some countries they are eagerly sought after, when in season, by divers employed to procure them.

In ancient times, indeed, they seem to have been regarded as delicacies, "when dressed with honied-wine, parsley and mint;" nay, it is recorded that they composed the principal dish at the famous supper of Lentulus, when he was made Flamen Martialis, or Priest of Mars, a circumstance which, seeing their abundance upon the shores of the Mediterranean, is by no means a matter of surprise to any one who has visited those enchanting regions.

We remember upon one occasion being not a little amused at witnessing the grotesque employment of sea-egg fishing near the bay of Naples. After a hard day's walking along the coast in the vicinity of Baiæ, we were taking our siesta beneath the shade of some vineyards within the classic precincts of the Elysian fields, eating delicious grapes purchased at the rate of about a penny a hatful, and literally

"Lapp'd in Elysium,"

were enjoying the delightful prospect, when it was proposed by our cicerone to visit the Baths of Nero, as he was pleased to call them, situated at no great distance. Now in Italy, after a day's pedestrian exercise under a burning sun, the very name of a bath has

something refreshing in it; and, allured by the anticipation of a plunge in some cool fountain, perhaps received in marble basins under vaulted roofs worthy of imperial magnificence, we were tempted from our shady seclusion, and set forth in quest of the promised indulgence. The day was blazing hot, and anxiously did we look forward to what we hoped would be some gelid refuge from the burning sunshine. The reader will therefore appreciate our feelings, when, on reaching our destination, the so-called "Baths of Nero" (*Le stufe di Nerone* is their proper designation) were boiling waters somewhere in the bowels of the earth, which we were called upon to visit. A low-browed cavern opening on the shore steamed like a laundry upon washing-day, and, certainly, anything but realized our pleasurable anticipations. However, there we were; and, as the stoves of Nero were declared well worthy of inspection, we prepared for the exploit.

We entered first a sort of ante-cave exceedingly like the entrance to some of the caverns about Matlock in Derbyshire, and there we found our guide, that was to be, into the realms below—a strange old man—a very Charon in his looks—a sort of Charon parboiled. Here we were told to strip ourselves quite naked to the waist, and, after obeying this direction, were furnished with a candle in one hand, and a basket containing a couple of eggs in the other, and thus accoutred were ready for our subterranean explorations. On opening an inner door, the steam burst forth as if from the spout of a teakettle. Our guide went first, assuring us that if we stooped so as to avoid the upper stratum of vapour, we should suffer

no inconvenience; and, with something like the feelings of Dandie Dinmont when about to enter Hatteraick's cave, we followed.

We have heard, gentle reader, of a man who went into an oven in company with a leg of mutton, and stayed there until it was cooked; but to have imagined ourselves voluntarily submitting to the fate of a potato, was a stretch of fancy of which we were not previously capable. However, we did it; yes, on we went, deeper and deeper, hotter and hotter. O ye Tartarean shades, we expected to see some of you then! At length we reached the margin of a stream, a boiling, hissing, bubbling, scalding stream. Cocytus?—Phlegethon?—I know not which it was; how could we tell, by the light of a single farthing candle, what might be around us in those regions of black darkness? We expected Cerberus to catch us by the trowsers every moment; however, we dipped our baskets of eggs into the dreadful caldron, and held them there till they were boiled. In doing so, I put the tips of the fingers of one hand to the ground to steady myself, and scalded them every one till they were blistered—it was hot work. I began to fear I should faint, and my heart beat against my ribs very unpleasantly. It was high time to be getting back again, and I believe Dante himself was not more pleased to see the stars appear, after his journey in the realms below, than I was to inhale another gasp of upper air. My first impulse was to rush into the Mediterranean, which lay gently heaving close at hand:—

"There shrinks no ebb in that tideless sea,
Which changeless rolls eternally:

So that wildest of waves in their angriest mood
Scarce break on the bounds of the land for a rood;
And the powerless moon beholds them flow,
Heedless if she come or go;
Calm or high, in main or bay,
On their course she hath no sway.
The rock unworn its base doth bare,
And looks o'er the surf, but it comes not there;
And the fringe of the foam may be seen below,
On the line that it left long ages ago,—
A smooth short space of yellow sand
Between it and the greener land."

I had not swum very far from the beach before I found myself surrounded by some fifty or sixty human heads, the bodies belonging to which were invisible, and interspersed among these perhaps an equal number of pairs of feet sticking out of the water. As I approached the spot, the entire scene became sufficiently ludicrous and bewildering, more especially to one so lately

"'scaped the Stygian pool,"

and whose head was still filled with visions of Dante's Inferno. Down went a head, up came a pair of heels —down went a pair of heels, up came a head; and as something like a hundred people were all diligently practising the same manœuvre, the strange vicissitude from heels to heads, and heads to heels, going on simultaneously, was rather a puzzling spectacle.

On returning to the beach, after a most delicious bathe, we were, of course, curious to inquire the meaning of such unintelligible gambols, and soon found out the cause of proceedings so mysterious. It was the "sea-egg" fishery, and these were fisher-

men, all busily employed in tearing from the rocks the valued edible. Yes, the villas of Cicero and of Lucullus, the Brighton of Imperial Rome, had occupied that strand, or been submerged beneath these waves; and over tessellated pavements and sculptured columns, plainly visible, now crawled Echini and Star-fishes.

The eggs of the Echinus, when first hatched, give birth to creatures exactly resembling infusorial animalcules, or perhaps we ought rather to say, the newly-born ciliated offspring of the Medusæ, described in a preceding chapter; but they soon change their appearance, and are then found swimming about as *Plutei*, very much resembling those from which the Ophiuri derive their origin (Pl. IV. fig. 1 *b*). The form of the *Pluteus* of an Echinus is, however, of a slightly different shape: its body is composed of a colourless transparent jelly, dome-shaped behind, expanded and slightly hollowed out in front, and prolonged inferiorly into straight slender legs, in which delicate rods of calcareous matter are perceptible, forming a kind of framework. Were the creature to stand upon these, it would in fact almost exactly resemble a French clock, such as we see on our chimney-pieces, the pendulum being represented by a proboscis-like mouth and its appendages: nothing indeed could be more remote in appearance from the Echinus into which it will be ultimately transformed. The little creature is in this stage of its existence a free-swimming animalcule, and propels itself, with its base and processes directed forwards, by means of powerful cilia grouped in two bunches on the sides of its

vaulted body, resembling epaulettes. It is also provided with a fringe of cilia encircling the dome, and continued upon all the columns up one side and down the other.

The first evidence of the approaching change of this *Pluteus* into an Echinus is the formation of a round disc like a clock-face, with five double lines like pointers radiating from its centre, and at their extremities expanding into circles, having a double outline, which may be soon seen to form the bases of tentacles like those that traverse the ambulacral pores of the adult Echinus, but which are as yet single, not in pairs. The disc or clock-face progressively expands, extending over the gelatinous mass to which it owes its origin, and developes tubercles which push through the transparent dome of the *Pluteus*, and are transformed into spines and tentacles that soon manifest their characteristic motions, combining their apparently voluntary actions with the continued vibrations of the ciliated epaulettes of the *Pluteus*; so that it can now both swim and creep. Gradually, however, as the growth of the Echinus advances, the *Pluteus* disappears, and even by the time the disc has expanded half over its surface, little of the latter remains except a few of the calcareous rods which formed its framework; while the nascent shell of the Echinus, covered now with spines and locomotive tentacles, plainly indicates the approaching completion of this wonderful, and, until recently, unheard-of transmutation.

The attention of naturalists has long been directed to a peculiar animated organization met with upon

the Echini, of which no satisfactory explanation has been as yet given. Numerous short, hair-like appendages, each having a peculiarly constructed summit or extremity, are interspersed amidst the spines of the Echinus, and apparently implanted on the epidermis of the shell; to these structures Müller, who deemed them parasitical animals, gave the name of *Pedicellaria*. The Pedicellariæ are, in truth, void of any resemblance in form, action, or substance, to the spines or suckers. They present themselves under two different aspects; but whether these are merely different stages in the growth of the same object, still requires investigation. In one set of these organs, the hair-like stem is crowned with a globular structure of solid appearance; in the other, the summit is divided into three leaf-like blades, which are capable of opening and closing like a three-bladed forceps, so as to clasp and retain minute fragments between them. The hair-like stem is cylindrical, and contains in its centre a jointed calcareous framework somewhat resembling the stem of an Encrinite (Pl. IV. fig. 6 *b*).

These Pedicellariæ cover the Echinus by thousands. They are of various dimensions, in large specimens some of them being half an inch in length. When seen rising from the fine red epidermis of the living Echinus, the movements of these remarkable appendages are very conspicuous, as they bend from side to side, the head of each describing nearly a circle, and the pincers opening and shutting with great vivacity.

From the nature of the localities they frequent, the Echini are necessarily much exposed to bruises and other injuries; their foes likewise, both in the

shape of fish and worm, are numerous. From the latter they endeavour to protect themselves by means of their spinous panoply, which they can erect and stiffen, presenting a thousand spears on every side, leaving no point unguarded; the bruises they bear with impunity, and it must be a very severe wound from which they cannot recover, if they are endowed with the same reparative powers as other Echinodermata. Monro even mentions that he has seen the pieces of an Echinus when broken up walk off in different directions; but what became of them subsequently he does not tell us, neither are we acquainted with any direct observations concerning the extent to which these creatures are able to resist or repair mutilation.

CHAPTER XXIII.

HOLOTHURIA—SEA-CUCUMBER.

"WHO has been meddling with the barometer?" exclaimed an old friend, as he raised his eyes from a chicken that he was in the act of carving, and accidentally took a glance at that useful instrument hanging against the wall. It was a wheel barometer, and was pointing steadily to "Set-fair." Now, as there was nothing in the state of the weather to indicate the realization of so agreeable a promise, it naturally excited suspicion that the weather-glass had been tampered with; but such was not the case, the fact being, that the index, having exhausted the entire gamut of its lower notes, "Rainy," "Much rain," "Stormy," &c., had positively encroached upon the scale *in alt.*, and had entered upon the fair-weather prophecies in an inverse direction.

That evening there arose a storm, and such a storm as we shall not easily forget. The wind, roused to a perfect hurricane, blew right on shore; the sea, one broad expanse of foam, rolled mountains high, and, as the billows thundered on the beach, their spray was driven inland in blinding sheets. The streets were all deserted; every house was tenantless, for all had hurried to the cliffs, and every eye was strained

upon the offing, where a ship was dimly seen battling the raging elements. It seemed a fearful struggle. Up she rose into full view, and then she disappeared behind the waves;—again she rises, as the seas lift her on high;—again she vanishes from sight, or but her reeling masts are visible;—she is evidently driving rapidly on shore.

It is by no means our intention, gentle reader, to lay before you in detail the horrors of a shipwreck; too frequently, alas! does the sad reality of such a terrible episode break in upon the tranquillity of a residence upon the sea-coast. But oh! the agony, the prayers, the breathless silence, and the stifled groans of the spectators, as that ill-fated vessel nears her doom, and yields to the audacious waves, that seem to triumph in their victory!—

"High o'er the ship they throw a horrid shade,
And o'er her burst in terrible cascade.
Uplifted on the surge, to heaven she flies,
Her shatter'd top half-buried in the skies;
Then headlong plunging, thunders on the ground—
Earth groans, air trembles, and the deeps resound.
Her giant bulk the dread concussion feels,
And quivering with the wound, in torment reels!
Again she plunges!—Hark!—a second shock
Tears her strong bottom on the marble rock.
Down on the vale of death with dismal cries
The fated victims, shuddering, roll their eyes
In wild despair; while yet another stroke
With deep convulsion rends the solid oak:
Till like the mine, in whose infernal cell
The lurking demons of destruction dwell,
At length asunder torn, her frame divides,
And, crashing, spreads the ruin o'er the tides."

It was on the day following such a scene that we visited the beach, and witnessed for ourselves the wild havoc caused by the storm. The shore was strewn with fragments of the wreck, some of which told too well what Ocean can be in her angry mood. Huge beams of oak lay snapped, as though they had been willow-wands; thick iron bolts, wrenched and contorted, looked like writhing snakes, and masts and spars and boxes lay around in terrible confusion. The sea, however, was now tranquil, and as it glittered in the sunshine seemed as innocent as any playful child.

Let not the reader suppose, however, that these alone remained to tell how violent had been the fury of the tempest. On visiting the scar where we were wont to pass the hours of the ebb-tide in search of specimens, we found a harvest, such as only similar occasions offer to the most enterprising naturalist. Scattered in rich profusion on the sand, or huddled together in heaps among the rocks, involved in rolls of sea-weed, or ensconced within the holes and crannies of the ragged barrier of stones that kept them prisoners, Fishes and Zoophytes, Mollusks and Acalephs lay stranded by the surge in most bewildering plenty; for, unfortunately, it is with the naturalist as with the angler, too abundant sport is less appreciated than one good fish.

In the midst of this chaos, however, we were not long in discovering something that fixed our notice; and a shapeless lump it seemed, about as unattractive to the eye as anything could be. We picked it up, and consigning it to our jar, felt we had got a prize.

As we were returning home with a rich cargo for

our vivarium, we encountered an old fisherman, our companion in many a hard day's work. "Fine time for you, sir, after last night's storm. Weel, and what hae ye got?" "A splendid *Holothuria*, John," was our reply, at the same time displaying our captive treasure. "Eh?—a what?—a what d'ye call it?—why it 's naught but a *sea-pudding*!"

Now we are quite aware that with a certain class of naturalists it is laid down as an axiom, that all the productions of the land have their representatives in the ocean; but, verily, a *sea-pudding* we could not help thinking to be rather stretching the analogy so pointed out as a law of creation. However, leaving John to chuckle over his superior knowledge, we proceeded forthwith to introduce our *Holothuria*, for so we must persist in calling it, to its new domicile, wherein we might observe it at leisure.

The hard name *Holothuria*, which puzzled our fisherman, is derived from a Greek word of uncertain application (ὁλοθούριον), and is employed to designate a group of animals very nearly related in their internal structure to the Sea-urchins, although widely differing from them in outward appearance. In common language they are generally known by the appellation of "*Sea-cucumbers*," or "Sea-gherkins," and in fact, to a casual observer, the resemblance which some of them bear to those productions of the vegetable kingdom is sufficiently striking.

The exterior integument of the Holothuria is tough and muscular, and constitutes a capacious bag, wherein are contained the respiratory and intestinal organs, and the ovarium. The head is also contracted

within it when the animal is at rest; but when in action, it is protruded, unfolding a luxuriant flower, or arborescence, composed of a circlet of branching tentacula. The body of many specimens, when in its most natural position, assumes the form of a horseshoe or crescent, and a stream of water, playing like a fountain, is at intervals forcibly discharged from its posterior extremity.

Few animals are apparently more helpless than a Holothuria when found cast up upon the beach, as was the case with the specimen in our vivarium; and yet, with the exception of the Echini, few have been more liberally provided with locomotive organs. On placing one of them in a tank of sea-water, down it sinks to the bottom, and there it lies, to all appearance as limbless and incapable of progression as a Bologna sausage, and in this condition it will probably remain for hours, without the slightest promise of activity. At length, to the amazement of the beholder, it begins to stir; nay, it begins to creep along until it reaches the transparent side of the tank, and then, amazement on amazement! it soon proceeds to climb, like a great slug, up its perpendicular surface, gliding onwards with a slow and measured movement in a manner that seems at first perfectly incomprehensible. Close inspection, however, especially if aided by a magnifying-glass, reveals the astonishing machinery employed for this purpose. The whole surface of the body of the animal is found to be covered with innumerable locomotive suckers, which, both in their structure and mode of action, exactly resemble those of the Echinus described in

the last chapter, and which are protruded through innumerable orifices that perforate the integument. In some cases, as in *Holothuria frondosa*, these suckers are arranged in five series, disposed like the ambulacra of the Sea-egg; in other genera they are only found upon the middle of the ventral surface of the body, that forms a flattened disc wherewith the animal creeps, somewhat in the manner of a snail.

In *Holothuria pentactes* five longitudinal rows of suckers traverse the skin, extending the length of the whole body, commencing near the root of the tentacula, and terminating at the posterior orifice; and it is by the adhesion of these suckers that the animal is enabled to attach itself firmly to any solid substance. About a hundred suckers may, in a moderate-sized specimen, be counted in each stripe. In some, five or six or seven suckers are placed in a row, near the middle of the creature's body, the number gradually decreasing towards the extremities, while in young specimens only a double row of these suckers is met with. Thus the number of suckers appears to augment with the age of the animal. These suckers can be wholly retracted and sunk in the flesh, so that the animal then seems entirely divested of external organs.

We learn from a paper by Mr. C. W. Peach, read before the Royal Polytechnic Institution of Cornwall, that a species of Holothuria, called the "Nigger," or "Cotton-spinner," by the Cornish fishermen, is very common in deep water off that coast, and is held by them in great detestation, from its throwing out what they call "cotton," and also because where the

"niggers" are numerous, and get into the crab-pots, it is very rarely that either crabs or lobsters are caught. Their appearance, when closed up, very much resembles a small cucumber, their back being dark, almost black at times, and the under part light yellowish green. Around the base of the tentacula is a border of spines very much resembling the thorns of the brier, and similar spines are distributed over the creature's back. The under side of the body is furnished with very numerous suckers, which they can stretch out to a great length, and by their means attach themselves firmly to foreign objects; so much so, indeed, that in trying to detach the animal, its suckers are not unfrequently left behind. Each sucker is provided at its tip with a small round calcareous plate, which, under the microscope, forms a very beautiful object.

This species of Holothuria is extremely irritable, and, on being touched or disturbed, throws out a bunch of white taper threads about an inch in length. These soon become attenuated, either by the agitation of the water, or by coming into contact with extraneous substances, until they are drawn out into long threads of great tenacity, which stick to everything they touch, and hence the name of "cotton-spinners" applied to these creatures by the fishermen.

Night appears to be the chief season for enjoyment and activity in these strange animals. Whatever be their contracted state during the day, they expand themselves at night, and display their beautiful arborescent tentacula at their utmost dimensions. Nevertheless, sometimes they will remain expanded through

the day, and even seem to become more erect on the approach of light. This, however, is certainly an exception to the general rule, for both light and heat seem to be prejudicial to their welfare.

When expanded, each tentaculum is apparently independent of its fellows, and each subordinate branch or twig of which the tentacula are composed, is free of all the rest. But so timid is the creature, that amidst the fullest display, and the most ample exercise of its arborescent organs, whilst sweeping them through the water in obvious enjoyment, the slightest shock, or an approaching taper, though the creature —as far as we know—possesses no eyes, interrupts the tentacular evolutions; the cylinder recedes, the branches contract, and the whole apparatus is quickly withdrawn, the shaggy coat closing over it, so as to leave not even a trace of the opening whence it issued; and then the animal will remain in pertinacious retreat, not only for the coming night, but for several ensuing.

According to Professor Delle Chiaje, the aliment of the Holothuriæ is principally composed of vegetable and miscellaneous substances: "Le Oloturie cibansi di figli di coralline, di alghe, di arena e di altre immondezze di mare."

Uninviting as is the appearance of these slimy creatures, the flesh of some species is used very extensively by the Chinese for culinary purposes. They make of it a very rich and palatable soup, and dress it in different kinds of stews. There are various modes of curing it. It is first opened and cleaned, and then laid in dry lime; afterwards, according to the circum-

stances of the fishing-station, it is dried in the sun or on stages by means of fires made of wood, placed under them. It is a most important article of commerce. There are fisheries, as they are called, of *Trepang* (the name by which this edible is distinguished) in every island of the Eastern Archipelago, from Sumatra to New Guinea. The whole quantity sent to China from Macassar and other parts may be estimated at 14,000 piculs, or in money at about £119,000, an estimate from which the reader may learn how numerously these creatures occur in tropical seas.

"On a reef of rocks near the island Raiatea is a huge, unshapely, black or brown slug, here called '*Biche*,' from six to seven inches long and five to six broad. It is caught in vast quantities, and not only regarded as a great delicacy by the natives, but, being cured, has become a valuable article of commerce to the China market, whither it is carried from many insular coasts of the Pacific by American ships. We have seen a number of lads fill three canoes in two hours with these 'Sea-snails'*."

Mr. Beale speaks of the "Bêche de Mer," found at Oahoo, one of the Sandwich Islands, being considered as a great delicacy, though "almost as tough as *caoutchouc*†."

It would be beyond our province upon the present occasion to describe the complicated anatomy of the interior of these remarkable creatures; whoever wishes

* Tyerman and Bennet, "Voy. and Trav. in the South Sea Islands."

† "Natural History of the Sperm Whale," p. 261.

to study more minutely this part of their economy, will find it described at length in another work*, or may easily satisfy himself by careful dissection, how elaborately arranged, and at the same time how delicate, is their internal structure; or indeed he need hardly take that trouble, as the complaisant creatures will not unfrequently dissect themselves in his presence, as though determined that, *coute que coute*, they will convince him concerning their wondrous organization. It is difficult, in truth, to keep some of them entire, for on the slightest insult or provocation many specimens will at once proceed coolly to disembowel themselves, as though out of sheer spite, and, by what seems to be an act of voluntary suicide, of which our reading furnishes no parallel, except in Jack the Giant-killer, defy alike the anatomist and his scalpel.

Dr. Johnston gives the following account of this voluntary ejection of the viscera in a common species, *Thyone papillosa* :—"The animal having been kept in sea-water unchanged for two or three days, sickened, and by the more frequent involutions and evolutions of its oral end, evinced its uneasiness. Being left unobserved in this state for an hour or so, I found on my return that it had vomited up its tentacula, its oral apparatus, its intestinal tube entire, and a large cluster of ovaries which lay about the plate. The muscular convulsion must have been very great, which thus so completely embowelled the creature; and yet life was not extinct, for the tentacula contracted

* "A General Outline of the Organization of the Animal Kingdom," by the Author.

themselves on being touched, and the empty skin appeared by its motions to have lost little of its irritability."

Lost little of its irritability, forsooth! Had Dr. Johnston only waited long enough, he would have found that the animal was all the better for the gentle depletion, and having got rid of such troublesome trifles as its old viscera, was quite ready to begin the world again with a new set!

> "The times have been
> That when the brains were out the man would die,
> And there an end!"

Not so, however, with our Holothuria. We have at this moment before us, in a jar of spirits of wine, wherein they have been quietly inurned during the last six months, the entire inside of one of these creatures—mouth, tentacles, alimentary canal, respiratory tree, ovarian tubes and all—and yet, in yonder tank, the animal itself, to which they once belonged, is creeping leisurely about his mimic rockery, apparently as well and active as if they still formed an integrant part of his economy, and brandishing a new set of tentacula quite as complete as their predecessors.

At the meeting of the British Association in Glasgow, Sir J. G. Dalyell first stated that he had witnessed in a Holothuria this wonderful power of reproducing, not only trifling portions of its body, but absolutely all its viscera. I have observed, says Sir John, the tentacula with the cylinder (dental circle), mouth, œsophagus, lower intestinal parts, and the ovarium separating within, and leaving the body an empty sac behind. Yet it does not perish. In three

or four months all the lost parts are regenerated, and the animal continues to live as if nothing had happened. The details of this process the reader will find in the following graphic narrative.

Between a fortnight and three weeks after the acquisition of a specimen of *Holothuria fusus*, says Sir J. G. Dalyell*, the tentacular apparatus, imperfectly expanded, protruded for the first time along with the cylinder upon which they are supported; from the upper part of the body next day a large portion of the intestine descending from it came forth also, and the animal, having crawled up the side of the vessel, allowed most of the shelly fragments adherent to its skin to fall off. No external symptoms of suffering were demonstrated, yet it was reasonable to apprehend that these and some other marks of weakness were the prelude of decay; and this apprehension was increased on witnessing the separation of all the organs thus protruded from the body, which dropped off on emptying the vessel for replenishment. Still the Holothuria seemed no more affected than before: assuming an oblique position, it mounted up the side of the glass as far as the edge of the water, where it remained immoveably fixed.

The detached organs perished and decomposed in a few days; not so, however, the rest of the animal, which survived for a length of time quite unaltered, and indeed soon gave signs that Nature had something in preparation.

The mutilation had occurred on the 4th of De-

* The Powers of the Creator displayed in the Creation, vol. i. p. 50.

cember. From the 14th of that month the body of the decapitated Holothuria remained stationary, rather lower than the surface of the water.

On the 25th of February, or eleven weeks subsequent to the date of mutilation, symptoms of the reproduction of the missing parts began to be apparent, and in a little time short, transparent, regenerated tentacula were displayed, still however very imperfect in comparison with their predecessors. On the 27th of the month the new tentacula were fully exhibited. In another week they exceeded an inch in length, and in fifteen weeks they were found to be complete in every point, sweeping the water, and performing all their natural functions, with as much activity as their predecessors!

The *Holothuria œcnus* (Dalyell) exhibits a still more remarkable phenomenon in the spontaneous division of its body into two or even a greater number of parts. Neither does this violent proceeding, as it might appear, prove fatal to the specimen. On the contrary indeed, the defective organs are regenerated complete in each of the portions, thus speedily renovating them into entire animals! Two individuals of the *Holothuria œcnus* were obtained by Sir J. Dalyell from the Mar Bank; both were active. While at rest they adhered by their peduncles or suckers to the glass near the surface of the water: each of these, after a short confinement, having apparently quarrelled with itself, broke itself into two nearly equal halves—an act which, in ordinary cases, might have been regarded as suicidal. Instead, however, of having rendered themselves liable to a verdict of *felo de se*, Sir

J. Dalyell witnessed with considerable surprise, after the lapse of three or four weeks, the regeneration of a complete set of arborescent tentacula in each posterior half of the two specimens, and all four parts were moving gaily about in their tank, completely furnished with their tentacular apparatus. This, however, was not all: in another week the anterior portion of the Holothuria sundered again near the middle, so that what originally constituted one entire animal now consisted of three parts. Afterwards another portion separated from one of the five parts at that time in the vessel, but from which was uncertain—if from the smaller, each of the original Holothuriæ had divided into three. All continued shifting their places, and some of them occasionally displaying their tentacula until May 27th of the following year, when the whole six were complete and perfect animals.

The remarkable subdivision of these creatures, Sir J. Dalyell observes, does not appear to result either from constraint or from injury; nay, there is nothing to show that the Holothuria undergoing such disruption suffers very much during the process.

Condensing the substance of these and other observations, it appears that the spontaneous separation above described ensues th. The specimen remains stationary during some time on the side of its vessel, when each extremity broadens, and flattens beyond its usual dimensions. This flattening occupies a considerable portion of the body, but diminishes from the broadest parts situated anteriorly and posteriorly towards the middle of the animal, giving it somewhat the appearance of a common sand-glass. At length

only a slender isthmus connects the two halves, and this becomes soon a mere hair-like thread, which, being ruptured, leaves the original animal either in equal halves, or consisting of a greater and lesser portion.

The duration of this process is very irregular; neither does it seem influenced by size or season, or any other condition. Separation frequently takes place in the night without previous indication; at other times it may be seen in progress during three or four days.

The animal seems literally rent asunder, and the intestinal organs, occupying a large portion of the interior of the body, are undoubtedly rent asunder also, so that obviously an internal reproduction must ensue as wonderful as the external reproduction of the arborescent apparatus.

The spawning of the Holothuria occurs in February, March, April, May and June, when many thousand ova are produced by a single individual. The larva—for such we may designate the young progeny on its first escape from the egg—resembles a bean-shaped animalcule, having its back convex, while an irregular transverse fissure, answering to what botanists would call the *hilum* of the bean, indicates the position of the mouth. The margins of this fissure are edged by a ciliated fringe similar to that of the *Pluteus* described in the last chapter. In the course of its growth the margins of the larva and the corresponding parts of the fringe are thrown into numerous lateral processes, giving it a scolloped appearance. By slow degrees, the creature next assumes a barrel shape; the former mouth of the larva becomes obliterated,

and a new and permanent one is gradually formed, surrounded by a circlet of tentacular appendages; the locomotive suckers ultimately make their appearance, and the swimming animalcule is thus slowly converted into the wonderful "Sea-pudding" we picked up upon the beach.

CHAPTER XXIV.

SIPUNCULUS.

"From Nature's chain, whatever link you strike,
Tenth or ten thousandth, breaks the chain alike."

EVERY traveller must have observed, on approaching the boundary-line which separates two countries differing in language, how gradually the transition is effected by the interposition of some unintelligible *patois*, which, partaking equally of both, belongs to neither. Precisely in the same manner the Zoologist, as he nears the confines of the subkingdoms, or even the provinces marked out upon the grand chart of Natural History, is sure to encounter forms of life so doubtfully combining the characters of most opposite races of beings, as to defy the nicest criticism to pronounce on which side of the border they ought to claim allegiance—a fact of which the Sipunculi, the subjects of the present chapter, afford us a very interesting example.

The Holothuriæ, as we have seen, notwithstanding their elongated form and soft integument, still retain the locomotive suckers which so peculiarly characterize the star-fishes and the sea-urchins; and from

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the rudeness of their shape, and the general inflexibility of their bodies, it is evident that without such a provision they would be, of all animals, the most helpless and incapable. The Sipunculus, on the contrary (Pl. V. fig. 1), might, from its external appearance, almost be mistaken for an earthworm, or at least for one of those marine Annelidans met with abundantly on every shore. The body of these animals is indeed completely vermiform, although not as yet distinctly annulose, that is, divided into regular rings or segments. In them, to use the words of Professor Forbes, RADIISM sets, and ANNULISM appears. In their internal structure, however, they are distinctly Echinoderms, although even here a transition towards the annulose type is perceptible. They have no rows of suckers; their bodies are no longer divided into a quinary arrangement of lobes or rays, and the tentacula around their mouths are no longer regulated by a definite number. Their motions and habits are those of worms. Instead of having their skins strengthened by calcareous plates or spines, such as have prickly appendages are furnished with horny bristles nearly resembling those seen in many Annelides, whereby their movements are to some extent aided. Posteriorly the body of the Sipunculus is capable of dilatation into a sort of bulb; while at its anterior extremity it is provided with a long fleshy proboscis, at the extremity of which is situated the mouth, surrounded with a flower-like circlet of tentacula. This proboscis, when not in use, is completely retracted into the interior of the animal, folding up like the horns of a snail, until not a trace of it is visible externally.

The Sipunculi are frequently to be met with near low-water mark, inhabiting holes which they excavate in the sand to a considerable depth, lining them throughout with a calcareous secretion, much in the same way as a well is lined with brickwork. In these retreats they move up and down with great facility, coming to the surface when the tide is up, and displaying their flower-crowned proboscis; but withdrawing themselves rapidly, when disturbed, into their holes, at the bottom of which they hold themselves firmly by means of their dilatable posterior extremity.

In China, where worms of all sorts are looked upon as delicacies, the Sipunculi are by no means excluded from the table of the epicure, but, on the contrary, are regarded as high-class luxuries; and one species, the *Sipunculus edulis,* constitutes, like the *Trepang,* an article of commerce. It is met with in great abundance on the shores in the vicinity of Batavia, on the coast of Java, where it is called *porrest ajang* by the natives, and *soa-sec* by the Chinese, who come there to catch it. It is found at the depth of from a foot to a foot and a half in the sand, in holes which, being always open at the top, are easily distinguishable; and the mode in which this strange fishery is conducted is, as we are told, as follows. At every low tide the Chinese fishermen assemble on the shore in troops, each bringing with him a bundle of slender rods made of cane, each rod being sharpened at one end, and having a little ball or button just above the sharp point. Arrived at the fishing-ground, the Chinaman proceeds to drop one of these rods with its point downwards into every hole, and there leaves it until

he has exhausted the whole bundle. After a little time he returns, and, having previously removed the sand to a proper depth, gently draws forth the rod, to which by this time the animal has attached itself by swallowing the button. The Sipunculi are thus procured in considerable quantities, and are cooked in various ways, "either with garlic, or with *garo sooy*," condiments which, to most of our readers, will probably be scarcely more appetizing than the worms themselves.

The food of the Sipunculi seems to consist entirely of such *débris* of animal or vegetable substances as chance brings within reach of their proboscis. As in the other Echinoderms, their alimentary canal is always found filled with sand and broken fragments of shell.

Whilst the generality of the Sipunculi bury themselves in sand, or hide in the crevices of rocks, there is one remarkable species (*Sipunculus Bernhardus*, Forbes) found on most parts of the British coast, which, after the example of the Hermit Crab, adopts for its abode the shells of univalve testacea, in one or other of which it constantly resides. This Sipunculus, however, would appear to be of a less changeable disposition than its crustacean analogue, for, when once securely housed in a shell, it makes that its permanent residence*. Whether the egg is originally deposited in the future habitation of the animal in obedience to some wonderful instinct, or is only developed when lodged by the water in such a locality, or whether the parent Sipunculus bequeathes the chosen

* Forbes, British Star-fishes.

lodging of its caudal termination to its eldest born, and so on from generation to generation, a veritable *entailed* property, we know not at present; but the inquiry is a most interesting one, and well worth the attention of the experimental zoologist. This Sipunculus is not, however, content with the habitation built for it by its molluscan predecessor; it exercises its own architectural ingenuity, and secures the entrance of its shell by a plaster-work of sand, leaving a round hole in the centre sufficiently large to permit the protrusion of its proboscis, which it sends out to a great length, and moves about in all directions with the utmost facility. This proboscis is long and cylindrical, and slightly enlarged at its extremity, where it is surrounded by a circlet of tentacula, which however are very seldom protruded. Behind these tentacula are four circles of minute bristles. The proboscis can be entirely retracted within the body when not in use.

The shells selected by this Sipunculus for its habitation are usually specimens of the *Strombus Pes-Pelicanus* and *Turritella terebra*; it is also occasionally to be met with in *Littorina littorea*, when that shell happens to be in sufficiently deep water; and *Dentalium Entalis* is likewise sometimes adopted. The *Sipunculus Bernhardus* is by no means rare; but, as it lives in from ten to thirty fathoms water, is only procurable by patient dredging.

CHAPTER XXV.

NEMERTES BORLASII.

"It does not belong to mankind to pronounce upon the perfections or imperfections, the use or the uselessness of what has come from the hands of the Creator, or that the aspect or dimensions of one creature has rendered it more worthy than another of a place in the scale of beings."

About four or five miles from South Shields, upon the coast of Durham, is a locality called Marsden Rocks, well known to every Northern naturalist, and a favourite resort of pic-nic parties. It is a strange place, and, although now many years since we visited it, is associated in our mind with divers agreeable reminiscences. The whole of that part of the coast consists of magnesian limestone, which from its softness is easily worn away by the sea, and in many places is hollowed out by the action of the waves into extensive and picturesque caverns. In one of these, remarkable for its size and numerous chambers, that wind deeply into the limestone cliff, lived an old man, called Peter (the only name by which he was ever known to us),—a queer fellow, half-smuggler, half-publican, who had there ensconced himself, and, partly by the excellence of his whiskey, partly by the

shrewdness of his wit, managed to carry on a thriving trade among the numerous visitors to this romantic spot.

We shall not easily forget Marsden Rocks, or the naturalist friends we have encountered around Peter's sturdy table, while blue-lights and various-coloured fires burning at intervals in different remote regions of the cavern gave to the whole scene the aspect of some brigand's cave, from which emerging into the bright sunshine of the shore, the visitor is reminded of Gil Blas escaping from his subterranean prison.

The coast in the vicinity of Marsden is classic ground to the lover of natural history. It was upon this coast that Bewick studied his sea-birds, Joshua Alder and Albany Hancock their Dorsibranchiate mollusks, William Hutton his fossil flora of the coal-measures, Hewitson his birds'-eggs. It is here, in short, that the Tyneside naturalists are to be met with; and surely we need say no more in the way of apology for thus introducing it to our readers.

It was during one of our visits to this secluded spot, as, with a geologist's hammer in hand, we were busying ourselves in breaking specimens of the rocks, that are only accessible at low water, a lucky blow split off a fragment of considerable size, revealing to the day a fissure, within which lay, coiled in endless convolutions, one of the strangest animals we ever had encountered (Pl. V. fig. 2). It seemed to be a worm, but such a worm we thought as mortal eyes had never seen before—at least in the course of our reading we had never met with any account of such a monster, and presumed, of course, we had got some-

thing new. In this, however, we were disappointed: on subsequently turning over the pages of the 'Linnean Transactions,' we found that even here we had been forestalled by the Rev. Hugh Davis, and that by a description of the animal so graphic and circumstantial as quite to supersede our own notes upon the subject.

I laid, says Mr. Davis, a specimen of this wonderful creature in its own element in the largest dish I have, with a design to observe its habits and manners. It partook in some respects of the nature of the leech, seeming, like it, in some degree amphibious, as it frequently in part left the water, and, to the length of a foot or two, extended itself along the edge of the dish, and the table on which the dish was placed. At other times, particularly during the day, it was compactly collected together in a heap, and perfectly still, unless the dish or table was touched, of which it seemed very sensible. This it indicated by a vibratory motion of its whole mass, and by retracting the head and fore-part, which were generally somewhat extended. In the night I always found it coiled in a more lax and diffuse manner, covering nearly the whole dish; but on the approach of a candle, it seemed affected and inclined to contract itself, so that although I could not see that it had eyes, I was quite sure that it was very sensible of light. It frequently by morning assumed somewhat of a spiral or screw-like form, and on one morning in particular I was highly gratified in finding it almost perfectly and closely spiral from end to end. I was forcibly struck with this appearance, as it seemed to suggest the

solution of a difficulty which perplexed me much, concerning the manner how such a wonderfully soft, delicate, and seemingly unmanageable length of body could possibly move itself from one place to another. But from the moment when I observed this, I was convinced that this must be the state which the creature assumes when disposed to change its station; not only as thus it is contracted into the most compact size which its make is susceptible of, but likewise that when so modified, every spire or volution, by a distinct impulse applied in an appropriate manner, will assist in the act of progression by shifting forward the whole of its amazing length at the same instant, without danger of breaking.

When I took it up at the sea-side, collecting such an immense creature in a confused manner into an oyster-shell (a very large one indeed), I thought it would have been almost impossible to unravel it; but it is astonishing to think how readily it was disentangled, owing to the extraordinary smoothness of its surface.

It is impossible to make a guess at the length of it when alive, on account of its constantly extending and contracting itself when touched, and that with such ease as almost to exceed belief. I once observed a part of the fore-end extended to a length of between two and three feet along the margin of the dish and the table, which part, on the animal being disturbed, was in a short time contracted so as not to exceed so many inches; and as, when it was thus extended, it was full three times as thick as I have seen it upon other occasions, I may well say that it is

capable of extending itself, without any inconvenience, to twenty-five or thirty times the length that it presents at another period.

It varies very considerably in colour as it contracts or extends itself, changing from a dusky to a reddish-brown; but it has, when placed in a strong light, especially in the sunshine, a gloss of a fine rich purple all over: when most contracted, it appears nearly black.

Having thus watched this remarkable animal for a fortnight, giving it daily a fresh supply of sea-water, I put it into a bottle—which, by-the-by, though the bottle was wide-mouthed, I effected with no little trouble, owing to its facility of extending and contracting itself, and likewise from its being so slippery. When, however, this was done, I poured upon it some spirits. It was convulsed, and became greatly contracted in regard to length, and in an instant, to my great surprise, it projected from its head a proboscis which was eight inches in length. It is very strange, that during the space of time above stated, and the various treatment which the creature had experienced, it never in the least exhibited this part of itself till in its dying convulsion.

It being impossible while the animal was alive to make any reasonable conjecture as to the length of it, I took it out of the bottle and measured it after it was dead, when I found it to be full *two-and-twenty feet* long, exclusive of the proboscis. Now, I give it as my firm opinion, that I speak within bounds when I say, the animal, when alive, might have been extended to four times the length it presented when dead. I

therefore look at what Mr. Sowerby gives, on the authority of the fishermen at Newhaven, to be by no means improbable, viz. that this most astonishing creature may have been susceptible of being drawn out to the length of *twelve fathoms*; or, according to the account of the fishermen on the south coast of Devonshire, to Mr. Montagu, to *thirty yards*, or *fifteen fathoms*. Indeed, Mr. Montagu's own account of one of the length of *eight feet* when alive, being reduced to *one foot* when immersed in spirits, does more than support my opinion.

This and another specimen were found near Beaumaris at the time of spring-tide in the month of March.

The Nemertes is extremely liable to be broken, and its fragments retain their vitality for many months after their separation from the rest of the animal.

Sir John Dalyell was for a long time perplexed regarding the food of this remarkable worm. A creature so unwieldy and unmanageable in itself, appeared to be very ill-adapted for overcoming resisting prey: he ascertained, however, that in its natural state it invades the tubes of the Amphitrite in order to devour the tenant; and in one instance it seized and immolated a Terebella, which had lost its protective dwelling, and this too in spite of the size and apparently superior strength of the victim.

This animal frequently wraps itself up in an intricate knot, whence the derivation of the name 'Gordius,' applied to it by some authors; and perhaps food may become occasionally entangled among the voluminous folds of its body. It is certainly greedy

after what is readily got. Portions of mussel are always acceptable, and are speedily swallowed by the capacious mouth. If the valves of a small shell be sundered, the animal fastens on one of them, drags it away, and consumes the contents at leisure. The dimensions of the alimentary canal permit these strange beings to swallow a great quantity of food, whereby the creature appears very different in a state of repletion from the aspect which it presents during abstinence.

Stones or clean shells should always be stored in the vessels containing animals of this description, which they never fail to encircle with their folds, winding themselves round them as the knot wherein the body is involved gradually unfolds; and thus the rupture of the specimen is prevented, which otherwise frequently happens, either on account of the unmanageable length of the monster, or produced by immoderate repletion.

CHAPTER XXVI.

"All hail to the ruins, the rocks and the shores!
Thou wide-rolling Ocean, all hail!
Now brilliant with sunbeams, and dimpled with oars,
Now dark with the fresh-blowing gale.
While soft o'er thy bosom the cloud shadows sail,
And the silver-wing'd sea-fowl on high,
Like meteors bespangle the sky,
Or dive in the gulf, or triumphantly ride
Like foam on the surges, the swans of the tide."

GENTLE reader, was it ever your good fortune, in company with a stout pair of legs, a steady head, and a Cumberland friend, to climb the dizzy cliffs leading from Whitehaven to St. Bee's Head? If so, and you had a fine day for the excursion, it is a walk not easily to be forgotten; if not, we beg the pleasure of your company as we cursorily glance at the principal features of the scene. It is by no means child's play that walk; but as it is our privilege, we will, upon the present occasion, suppose ourselves already half-way advanced upon our road, and taking our stand here upon the summit of this cliff, survey the scene spread out in grand panorama around us. Behind us, in the purple distance, are the Cumberland mountains, Skiddaw and Helvellyn and Saddleback, looming through the haze, like the dim forms of Ossian's

giants: but it is seaward we direct our gaze—St. George's sun-lit channel and the Solway Frith—yonder the Scottish coast, stretching away for many a lengthy league—and there, upon the horizon, rests the Isle of Man. And now, with steady courage scan the depth beneath:—

"Come on, sir; here 's the place:—stand still.—How fearful
And dizzy 'tis to cast one's eyes so low!
The crows and choughs that wing the midway air,
Show scarce so gross as beetles: half way down
Hangs one that gathers samphire; dreadful trade!
Methinks he seems no bigger than his head:
The fishermen, that walk upon the beach,
Appear like mice, and yon tall anchoring bark
Diminish'd to her cock; her cock, a buoy
Almost too small for sight: the murmuring surge,
That on the unnumber'd idle pebbles chafes,
Cannot be heard so high:—I'll look no more;
Lest my brain turn, and the deficient sight
Topple down headlong."

Observe yon rocky mass, which, like a couchant lion, seems to guard the entrance to the port of Whitehaven, and against which the waves are dashing, flinging up their spray—that is the Tom Hurd rock.

And pray who was Tom Hurd, whose name is thus immortalized?

Ah! 'tis a sad tale, exclaimed my kind instructor. Poor Tom Hurd!—he was a fine young lad, sir—a sailor who was courting a young lass here at Whitehaven, when he was ordered off to sea, and for some years was never heard of; but his heart was true, and so was hers. At last his ship returned, and heartily Tom Hurd was welcomed back again, and cheerily

he ran to kiss his bonny Jane, who for so long had waited patiently to have him back. Well, nothing would serve poor Tom but he must have her with him down to Poulton (there—that village that you see some distance down the coast), to spend a day of happiness together. Alas! they little thought what fate awaited them on their return. Meantime a storm had risen, but Tom had faced too many storms to fear—bravely he pulled to gain the haven's mouth, and manfully he strove against the waves—vain was his strength against those giant billows rolling in, and madly raving on this fatal shore. There, on yonder rock, poor Tom's frail skiff was dashed to atoms, and his long-intended bride perished amidst the boiling surge, and disappeared for ever. He himself was cast up senseless, but alive, upon the shore.

Sad was his fate. There, for many a weary month, poor Tom was to be seen standing, silent and alone, gazing upon the place where all his hopes had sunk—till, in another storm, he saw the rolling breakers gathering round the giant pedestal on which he stayed unmoved as a marble statue, until a wave, engulfing him in its broad bosom, bore him off to join the lass so dearly and so fatally beloved.

Such is the legend of the Tom Hurd rock!

After thanking our friend for this somewhat tragical narrative, we again set out upon our walk along the cliffs—still mounting, as we skirted the grand precipice, along a path by far too near its edge to be either safe or agreeable to the feelings of a nervous person. At length we reached the culminating point of our excursion, the lighthouse which crowns the awful

summit of St. Bee's Head, standing 800 or 1000 feet above the sea. And here I parted from my friend, intending to return by the sea-beach, whereto, after some difficulty, I managed to effect a safe descent.

And here let me warn my readers, that, to look down upon a beach from the top of a high cliff, and to attempt to walk over it, are two very different things. In the present instance, most devoutly did I wish myself safely back again in upper air, and would at the moment have given a trifle for the loan of a pair of wings to any of the innumerable birds that screamed above my head. Shade of Cheops! Fancy a thousand pyramids as big as thine blown up, their giant masonry scattered in wild confusion over the ground, mass piled on mass, stones heaped on stones, and all worn smooth, and polished by mighty waves, that, in their fury, heave them up, and roll them here and there like pebbles—huge blocks as big as houses strewn about in all directions, thatched with sea-wrack, and slippery with ooze and slime! Sadak, when in search of the waters of oblivion, had an easy journey before him when compared with mine. How many hours I toiled and climbed, and crawled and waded, I know not. Suffice it, that at last I did emerge from that dread labyrinth of Cyclopian anarchy, dirty and torn and bruised, and wet and weary and forlorn.

In this sad plight, while sitting on a rock, doubtless as miserable-looking an object as the knight of the rueful countenance, I saw a human form advancing towards my resting-place, and on his nearer approach I could not but be struck at the romantic figure

before me; for certes, since the days of Robinson Crusoe, no man ever presented himself in such a garb in such a desolate place. A long red beard, worthy of an Eastern sage, swept down over his ample breast; and when he informed me that he was a hermit, who had retired from the society of mankind, and had built for himself a hut on that dreary coast, I began to look upon my new acquaintance with feelings in which pity and apprehension were strangely intermingled. However, as he courteously invited me to visit his cell and have some refreshment, I was by no means in a condition to refuse hospitality so frankly offered, and accordingly followed my new acquaintance:—

> "Far in a wilderness obscure
> The lonely mansion lay,
> A refuge to the neighbouring poor,
> And strangers led astray."

And now, be it known unto thee, gentle reader, that we have long been familiar with hermits' cells of all sorts and sizes, from that of the Hermit of Warkworth to that of Friar Tuck, and of course always knew them to be devoted to contemplation and study; but perhaps you yourself never heard of a hermit's cell with "MUSEUM" inscribed over the portal, or dreamed of such a collection of relics as were here crowded together by the anchorite, my worthy host; albatroses and tom-tits, African fetishes and Chinese gongs, ornithorhynchi from Australia and whales' jaw-bones from the North Pole, Kaffirs' tobacco-pipes and New Zealanders' heads, fiddles from New York and old shoes from Otaheite, monkeys and

magpies, ostrich-eggs and salamanders, all strewn about in admirable confusion. Truly we learned more wonders in the way of natural history, and heard more long yarns about the Cape of Good Hope during our refection in that hermit's cell, than we could lay before our readers in a whole volume; and when the worthy father, staff in hand, kindly accompanied us on our road homewards, and saw us safely out of harm's way, we had almost forgotten our toils, and heartily bade adieu to the Hermit of the Museum.

One of our principal objects in visiting Whitehaven was the study of the Annelidans met with upon that coast, and, from what the reader has already learned concerning the locality, matters seemed but little promising for our purpose. The investigation of the habits of these animals is a matter of some difficulty under the most favourable circumstances, and upon this occasion everything seemed adverse to our success. Tanks we had none; and even if we had had suitable vessels,—to have inundated the hospitable residence of our kind host, Mr. John Gibson, with sea-water, would have been, to say the least of it, hardly endurable by any stretch of friendship. But more than this, many of the Annelidans, whose habits we were desirous of studying, are by no means easy of observation; many of them bury themselves habitually in sand or mud—others construct factitious tubes, into which they retreat upon the slightest disturbance—many pertinaciously conceal themselves under stones—all shun the light, and thus baffle our attempts to get anything like a satisfactory view of them

whilst in their ordinary habitats. Labouring under these difficulties, we set to work, if possible, to surmount them; and, as many of our readers will doubtless be glad to learn how we succeeded, we shall now proceed to describe a vivarium of our own contrivance admirably adapted to such an emergency.

The Tom Hurd rock, although more or less completely submerged at high water, is during the ebb of the tide uncovered, and very easily accessible. Its wave-washed sides are hollowed into broad plateaus and ledges, on some of which are worn deep excavations, forming little pools, left full of water when the tide retires, wherein are growing corallines and various kinds of pretty sea-weeds. One of these pools seemed made exactly for our purpose: beside it was a seat, as comfortable as an old arm-chair, and close by this an elevated ledge that formed our table, such an one, as any microscopist might have envied, solid, flat, and firm—no fear of shaking there. The bottom of the pool we filled up to a proper depth with sand and clay and shingle stones, arranging these in different portions of our stony tank, so that each form of Annelide might find appropriate soil wherein to burrow. So far all was straightforward enough; but here lay the difficulty—when the rising tide attained a certain height, the rocky pool would be of course submerged, and, as the waves washed over it, our treasures would be scattered to the deep; we therefore sought out some flat stones, massive and square, with which we formed a lid something like that of an ancient stone-coffin, and, to make all more secure, piled other stones upon the top. Having accom-

plished this, we left our new vivarium to the surge, which now came rolling in.

The plan succeeded well. Revisiting our tank when the retreating tide had ebbed sufficiently, we found the cover undisturbed, and, on removing it, the water clear and pure, fit to receive whatever specimens the coast afforded. These were soon obtained, and many a happy hour we passed upon that rocky seat, contemplating the various beauteous forms whose history we now must hasten to describe.

CHAPTER XXVII.

PONTOBDELLA MURICATA—SKATE-LEECH.

"Gem, flower and fish, the bird, the brute,
Of every kind occult or known
(Each exquisitely form'd to suit
Its humble lot, and that alone),
Through ocean, earth and air fulfil
Unconsciously their Maker's will."

THE Pontobdella, or Skate-leech (Pl. V. fig. 3), preys on the living skate, and it is said also on other flat-fish, sucking their blood, which seems to constitute its proper food. The firm adhesion of the sucker to the skin of its prey must render this animal a cruel and inveterate enemy.

During the day this singular leech reposes in absolute quiescence, but towards evening its wonted coil relaxes into wider curves, and it rears itself erect, with the head turned inwards.

The Skate-leech propagates by eggs or capsules of a very remarkable configuration, which are more or less numerous, according to the fertility of individuals; and they appear either singly, which is rare, or in a considerable group, perhaps fifty, deposited on the exterior or interior surface of a shell.

Each of these capsules consists of a short stalk or

pedicle, surmounted by a spheroid, and supported by a kind of sole or sucker (Pl. V. fig. 3, *a*, *b*). The capsule is altogether about three lines in length, and the spheroid, which contains the embryo or young leech, about two lines in diameter. Such capsules are firmly agglutinated by the sole to the substance whereon they are deposited. They are originally white, or of the faintest carnation, of a fine, soft downy aspect, with the neck (stalk) orange or yellowish. They darken gradually from the time of their production, and in four or five days the original white is converted to olive-green or dull wax-yellow. They are produced singly, free from all gelatinous matter.

This capsule is a very singular object, quite peculiar, insomuch that it bears no resemblance to the egg of any other animal. It consists of a coriaceous, tough, thick integument full of tenacious, albumenous, brownish matter. It contains, when mature, only a single embryo, which penetrates the lateral umbo in issuing forth to the light. At this period the young leech is about an inch in length.

The propagation of this species is not strictly confined to any season, though belonging chiefly to the summer.

The Skate-leech is most patient of abstinence. It is extremely voracious in the natural state, but rejects all subsistence when in confinement, although in such a condition it survives a long time.

CHAPTER XXVIII.

SERPULA AND SPIRORBIS.

"And far beneath the tempest's path
In coral grots defies the foe,
That never brake in heaviest wrath
The sabbath of the deep below."
J. MONTGOMERY.

NATURALISTS divide the Annelida into *erratic* and *sedentary*. The former, as may be easily concluded, have no permanent abode; the latter occupy a fixed habitation, sometimes of very durable materials and solid construction. They are themselves its constructors, and many of them real architects of a very ingenious kind.

Among the tube-inhabiting or sedentary Annelides we shall describe a few of those most frequently met with upon our own shores, in order to illustrate their habits and general economy, selecting more especially such species as are best adapted to become residents in the aquarium, either on account of the elegance of their forms, or the interest attaching to their habits.

Every one must have observed that stones, dead shells, fragments of pottery, or any similar substances that have been sunk for a length of time in the sea, become covered over with irregularly-twisted cal-

careous tubes, which sometimes accumulate in great abundance; and not unfrequently masses of similar tubes are brought up from considerable depths by the lines of the fisherman. If, while the contained animals are alive, these be placed in a vessel of sea-water, few spectacles can be more pleasing than that which they will speedily exhibit. The mouth of the tube is first seen to open by the raising of an exquisitely-constructed door, and then the creature cautiously protrudes the upper part of its body, spreading out at the same time two gorgeous fan-like expansions, of a rich scarlet or purple colour, which float elegantly in the surrounding water, and serve as branchial or breathing organs (Pl. V. fig. 4).

The tube wherein the *Serpula* (such is the name of these beautiful worms) dwells is calcareous, being formed by an exudation from the creature's body, which, even under water, soon hardens into shell in a manner very similar to that whereby other shells are constructed; and in this tenement the limbless Annelide is of course destined to remain during its whole lifetime, fishing for such food as may be obtainable in the immediate vicinity of its residence.

The habits of these elegant Annelides are necessarily extremely simple. Immoveably fixed by means of their tubes to foreign bodies, and frequently at a considerable depth in the sea, all their movements are restricted to the mere act of protruding the anterior portion of their bodies to a little distance out of their shelly residence, so as to expose their beautiful branchiæ to the influence of the surrounding element; these, spread out like fans in the water, are

moved about with a gentle waving motion, and, both from their lovely tints and graceful appearance, are always elegant objects to look upon. This partial protrusion from their tube is effected by means of the little hook-like appendages to the various rings of the body, by whose assistance the Serpula climbs up the inside of its tube; just in the same way as the chimney-sweep climbs a chimney, or rather used to do, for we believe that sable race is now extinct. On the slightest alarm of danger intimated by the agitation of the surrounding water—for the animal has no eyes—it at once retires into its abode, and carefully closing the orifice by means of the parasol-like expansion upon its head, remains safe from the intrusion of its enemies.

We know but little as to the kind of food upon which the Serpulæ are nourished, and nothing at all concerning their mode of reproduction. It may be supposed, however, that they live upon aquatic animalcules, which are caught by the aid of their branchial tentacles; and we may likewise conjecture, from the construction of the calcareous tube, that the young are born without any such protection. Perhaps some of our readers may find an opportunity of enlightening us relative to these portions of their history.

The *Spirorbis* is another shell constructed by minute Annelidans, still more common than the preceding; for upon the beach it is scarcely possible to pick up a piece of sea-weed without finding it studded over with numerous specimens. The shelly tubes inhabited by these little worms are exceedingly

minute, seldom larger than pins' heads; and instead of being, like those of the Serpula, of an irregular twisted figure, they are rolled upon themselves in a regular spiral form, with one of the flat sides firmly cemented to the surface of the object to which the creature attaches itself.

When magnified (Pl. V. fig. 5), the neck of the Spirorbis is found to be furnished with a perfect operculum or lid, formed as in Serpula by a peculiar development of one of the tentacula in the vicinity of the mouth, which answers the purpose of a little door, and likewise with an elegant apparatus of branchial plumes.

A little reflection will at once show us why the respiratory organs of these tube-inhabiting worms are situated in so remarkable a position, being invariably attached to the neck of the animal, and not, as in other races of Annelidans, distributed on various parts of the body. Had the breathing surfaces been placed in any other situation, it is evident that while the worm remained in its shell, the water could never have obtained free admission to them, and consequently respiration would have been impossible; whereas, by the elegant arrangement adopted, the simple raising of the operculum which closes the orifice of the shell like a lid, or the slightest protrusion of the creature's head, suffices to ensure the due aëration of the blood, without unnecessarily exposing the little worm to danger.

CHAPTER XXIX.

SABELLA.

"Thus He who makes and peoples worlds still works
In secrecy, behind a veil of light:
Yet through that hiding of his power such glimpses
Of glory break as strike presumption blind."

EVERY sea-side naturalist has doubtless had frequent opportunities of remarking agglomerated clusters of sandy tubes, with numerous circular orifices, rudely resembling a honeycomb; or they may have noticed flattened tubes, composed more solidly of particles of sand agglutinated to the surface of shells; or it may be they have been struck with the appearance of some single conical tube of larger dimensions, neatly constructed of similar particles, with or without a silky lining, but altogether so fragile as to be qualified to offer very little resistance against violence. All these, whether weak or strong, solitary or conglomerated, confined or spacious, are the work of their respective tenants, the *Sabellæ*, a race of elegant Annelidans, generally of small size, whose presence in the aquarium will enable the student to pass many an agreeable hour in watching them while sedulously employed in fabricating these curious dwellings.

One of the commonest of these little architects is the *Sabella alveolaria* (Pl. V. fig. 6), the length of which is seldom more than three-quarters of an inch. Its head, or anterior part, is provided with numerous filamentary tentacula (about eighty in number). These organs are extremely flexible: one surface has a groove in the centre, and when completely extended, may be observed to be toothed on both sides, so as in some measure to resemble the weapon of a saw-fish in miniature. The body is round, and composed of numerous segments, some of which are provided with bunches of minute lateral setæ. A slender caudal appendage, generally folded up on the body, terminates its extremity; it consists of eight or ten joints, and is susceptible of some alteration of form.

Numerous eggs are produced at different times of the year, especially in June, August and October. They are generally of a purple colour, consisting of a darker nucleus within a gelatinous sphere. A specimen having been injured in the third week of October by separating a congeries of tubes, a vast quantity of purple ova issued from the wound; and on being removed to a watch-glass, the same specimen continued discharging thousands of ova, all of the same beautiful colour and regular ovoidal form. But neither they nor others have afforded any progeny.

The *Sabella alveolaria* is a lively active creature, whose most prominent property is the power of constructing for itself an artificial dwelling, composed of grains of comminuted sand intermingled with shelly fragments, or other indurated substances. But there seems to be a great difference in the solidity of the

dwelling, according to the position of the tube, or perhaps depending upon the resources of the architect. Thus we find the fabric, when presenting the shape of the segment of a cylinder, attached to some flattened surface, firm, durable, and capable of great resistance. It is not easily crushed. On the other hand, when cylindrical or alveolar it appears to be always more brittle. Most of these dwellings of the Sabella are lined with a fine silky substance formed of a gelatinous material that exudes from the surface of the body.

These animals testify a decided predilection while choosing the materials for their habitations, always preferring sand and comminuted shell. Pounded glass is sparingly and reluctantly employed, and, unless for a few fragments, is soon entirely rejected. But there is a striking difference in the character of the tubes: one is short and confined, giving little beyond mere accommodation for the body; while another is considerably prolonged, so as to afford a safe retreat in times of danger. The architect of a third seems to persist in advancing the fabric as long as it can procure materials, and never seems weary of working.

Night is the chief season of this architectural labour, though the worm is seldom guilty of perfect idleness.

By means of the tentacular organs and the cleft in the anterior part of the head, grains of sand are selected and adapted where they are required, a glutenous secretion securing each particle in its proper place; and thus the growing structure is progressively extended.

It is very interesting to watch the *modus operandi* of these quiet labourers; and the curious observer, who desires a distinct view of their operations, ought so to contrive matters that their advancing tube should come in contact with the sides of the aquarium. They then continue alike industrious; but frequently, as if to economise labour, the growing edifice is reduced to the segment of a cylinder, the transparent glass supplying the defective portion: in this manner, whatever passes within is sufficiently exposed. A *Sabella*, previously carrying on its operations in a watch-glass, will sometimes avail itself of the transparent side of a jar in the same manner. The greatest activity is always displayed during the warmest weather.

These animals quit their tubes when the water becomes vitiated, and sometimes without any such reason; seeming to suffer little inconvenience from the want of them.

Their food is unknown; nevertheless, they are easily preserved, specimens having been found to live thirteen months in confinement.

CHAPTER XXX.

AMPHITRITE VENTILABRUM— THE FAN AMPHITRITE.

"Unheard by them the roaring of the wind,
The elastic motion of the waves unfelt;
Still, life is theirs, well-suited to themselves,
Nor yet unuseful."

From the depth of 60 or 70 feet beneath the surface of the sea, a black leather-like tube is sometimes dredged up, affixed by the lower extremity to some solid foundation. Its position is erect, gradually enlarging upwards from a very narrow commencement. It frequently resembles a reed or vegetable stem of stunted growth, furrowed by age, with portions of the bark injured below by decay, but fresher and smoother above, where visibly more recent and entire. On the whole, when clear and perfect, this submarine product bears the narrowest resemblance to a tube of caoutchouc manufactured by human art.

On plunging this artificial-looking tube into a vessel of fresh sea-water, a few air-bubbles first escape from its orifice, and then the tip of a variegated pencil is seen gradually protruding, which suddenly unfolds as a splendid plume composed of many feathers (Pl. V. fig. 7). Let the slightest shock be communicated, and the whole instantly collapses and disappears

within the tube almost before its image has faded from the eye.

The head or anterior portion of the animal, which may be called the plume (though truly the branchiæ), is disposed in two vertical fans, so arranged as to form a complete funnel. In large specimens it exceeds thirty lines in depth, and is decorated with the most brilliant colours, brown, red, green, purple and gold, exhibiting a truly gorgeous spectacle.

Two triangular, pointed, brown and green antennulæ arise near the bottom of the funnel, and below there are two external fleshy lobes or trowels, with an organ like a tongue or scoop between them.

The mode in which this lovely Annelide constructs its tube is exceedingly curious. We will suppose a specimen with its plume fully expanded in a jar filled with its native element: in this condition, if a drop of liquid mud be dropped from above into the water so as to disturb its cleanliness, the animal immediately begins to rouse itself, and all the thousands of cilia that fringe its branchial plumules are discovered to be in vigorous activity, collecting, by their incessant action, the diffused muddy particles into a loose mass, which is soon perceived visibly accumulating in the bottom of the funnel. Meantime, the neck or first segment of the body, rising unusually high above the orifice of the tube, exhibits the two trowels, previously alluded to, beating down the thin edge as they fold and clasp over the margin, like our fingers pressing a flattened cake against the palm of the hand. During these operations, the muddy materials are seen descending between the roots of the

fans, towards the trowels; while another organ, perhaps the mouth, is also occupied, it may be, in compounding the preparation with adhesive matter. As the bulk of the muddy mass diminishes, the activity of the worm abates; it is soon succeeded by repose, and then the tube is found to have received evident prolongation.

From the observations of Sir John Dalyell, it appears that the branchial fans of the Amphitrite, when lost or mutilated, are, notwithstanding their complicated structure, speedily reproduced and rendered again efficient.

Amphitrite Bombyx. *The Silk-worm Amphitrite.*

The general structure of this Annelidan resembles that of the Amphitrite last described, both in the worm-like organization of its body, and in the luxuriant plume of branchiæ affixed to its anterior extremity, as also in the circumstance of its inhabiting a sheath or tube. This sheath, however, instead of being constructed of foreign materials, is entirely made up of an animal gluten, resembling silk, without any earthy particles being incorporated in its substance. The total length of this Amphitrite is about 3 inches, whereof the plume, composed of about sixty branchiæ, constitutes a third, while the body consists of sixty or seventy segments (Pl. V. fig. 8).

The plume is proportionately larger and more luxuriant than that of the *Amphitrite ventilabrum*; it is finely variegated with different shades of brown and yellow—orpiment orange is the colour which pre-

dominates on the body. This animal dwells in a tube surpassing its whole length, which is not of mechanical construction, but is formed by a spontaneous exudation from the entire surface of its body. When originally produced, this tube is as clear as crystal, completely displaying through its transparent walls the shape of its occupant: it seems indeed altogether made up of a silk-like secretion, and becomes quite opake with age. The secretion whence this tube is derived must be very copious, as several of them are sometimes secreted by the animal, one after another.

The *Amphitrite Bombyx* is a timid creature, and impatient of light. On the slightest shock, the plume collapses, and the animal at once retreats into its abode, closing the orifice of the sheath; but if left for a little time undisturbed, it again ventures to issue forth, rising slowly upward, as if to avoid deranging the order of its feather-like branchiæ.

These elegant Annelidans have been observed, in confinement, to spawn abundantly, covering the bottom of the aquarium with quantities of ova mixed up with a thin gelatinous matter. Spawning, indeed, continues during most of the summer, more especially during the months of May and June; but all attempts to rear the young progeny have hitherto proved abortive, and a most interesting problem yet remains to be solved, by ascertaining the earliest aspect under which the juvenile Amphitrite makes its appearance when first liberated from the egg.

When disappointed, however, in our inquiries concerning one interesting subject, it is gratifying to find satisfactory illustrations of another.

The present species, in common with the preceding, is endowed with an extraordinary capability of reproducing parts of its body, whereof it may be deprived by violence, or which may be consumed by disease, so that each mutilated animal again becomes perfect. The plume is liable to gradual loss of its peculiar parts,—the body is subject to deprivation of its plume, and yet the whole is reproduced in full and luxuriant perfection.

An observation made by Sir J. Dalyell affords satisfactory proof of this phenomenon, remarkable at any time, but more especially in animals so elaborate in structure as the creatures of which we are now speaking.

A specimen which had been recently obtained lost its plume completely on the 5th of April, and the separated portion, an inch in length, lay at the bottom of the vessel. In twenty-six hours the trunk of the body was invested with a delicate silken sheath. In fifteen days the rudiments of a regenerating plume arose from the fore part of the trunk in the form of several delicate shoots an eighth of an inch long; these soon became clothed with incipient fringes, and in twenty-three days from the date of mutilation the branchiæ had attained a third of the dimensions of those they were replacing (Pl. V. fig. 8, *a*, *b*, *c*).

In prosecuting this subject, about five lines, or a fourth of the body, was broken off, during an attempt to dislodge a specimen from its sheath. The wounds thus inflicted upon each portion healed speedily. Ninety-two days after this occurrence, a new plume was visibly apparent, sprouting from the upper portion

of the posterior half; and in 116 days, this plume, unfolded in nearly its natural figure, almost equalled half the length of the body. While the sundered fragment thus gained a plume, that of the original entire animal still subsisted; therefore, in this case, there were two contemporary plumes—two complete systems of branchial apparatus, in vigorous existence at once, on two portions which had constituted an integral animal,—a strange and wonderful example of the resources of nature in preserving from destruction creatures apparently so defenceless and incapable.

The theory of such reproductions, indeed, involves the naturalist in extraordinary embarrassment. It is sufficiently surprising that ordinary wounds or lacerations should heal—that the energies of the system should restore the integrity of mutilated organs essential for the preservation of the injured individual. But, to behold the evolution of the most complex structures, where none previously existed, nor could exist, in accordance with the general organization of the animal—or that its development should be dependent on an act of violence, is enough to perplex the most accomplished physiologist.

AMPHITRITE INFUNDIBULUM. *The Funnel Amphitrite.*

This remarkable Annelide is easily recognizable by its two semicircular tentacula, which, when spread out and united, form nearly a regular circle. Each tentacle is composed of about thirty-seven rays, connected by a transparent web, except at the points,

which turn a little inwards. The outside of these singularly beautiful arms is smooth, and of a purple colour, darkest at the tips of the rays; the inside is most elegantly ciliated with two rows of fimbriæ along each ray, of a chestnut colour, shaded to a purple near the centre (Pl. V. fig. 9).

This animal is capable of the most sudden contraction, from eight or ten inches in length to three or four. It has between a hundred and fifty and a hundred and sixty joints, gradually tapering towards the posterior extremity.

The case or tube wherein the animal lives is wholly gelatinous, of a very firm and elastic nature, greenish on the outside, but usually stained black by the soil the creature inhabits. These cases are composed of many layers or strata, and when the first coat is removed the remaining part is quite transparent, and the animal nearly as distinctly seen as through glass.

This elegant worm is occasionally met with uncovered at the lowest ebb of spring tides. The case is buried beneath the surface of the beach, and is only discoverable by a small portion which projects above, appearing like a piece of black jelly. When the tide returns, it displays its beautiful tentacula, but rarely exposes its body.

In its native abode it recedes on the slightest alarm; and when the gelatinous case is taken in the hand, and the animal is extended within it, the sudden contraction within the tremulous tube produces a singular and instantaneous vibratory shock, that, being unexpected, is rather startling, and might make a timid collector drop so valuable a prize.

AMPHITRITE AURICOMA. *Golden-hair Amphitrite.*

The *Amphitrite auricoma* fabricates a very delicate tube, as thin as paper, constructed exclusively of grains of sand, agglutinated together in an extraordinary manner. The thickness of the side of one of these pretty tubes does not exceed a single grain; each lies in its own proper place, and the whole is lined with the slightest silken coating. The sand being collected at the orifice of the tube, its tenant, chiefly by means of its tentacular organs, selects those which are appropriate and applies them to use. This is done only during the night; all the additions being made around the orifice, in proportion as the animal grows; so that the shape and dimensions of the tube, which is an inverted cone, result from the progressive growth of the body of the worm.

This Amphitrite is very timid. It dwells in deep water, apparently lying in a horizontal position at the bottom of the sea. The tubes are generally regular cones, but instances have occurred of tubes slightly curved, like the tusk of an elephant.

CHAPTER XXXI.

TEREBELLA LITTORALIS, *seu* ARENARIA—THE SAND MASON.

"Ruder heads stand amazed at those prodigious pieces of Nature, whales, elephants, dromedaries and camels; those, I confess, are the colossus and majestick pieces of her hand; but in these narrow engines there is more curious mathematicks, and the civility of these little citizens more neatly sets forth the wisdom of their Maker!"

Between half-tide and low-water mark, numerous cylindrical tubes may be observed projecting from among the rocks and stones of the shore, especially amidst sandy patches of ground. Some of these terminate in a tuft, like the ragged end of a hempen cord; and on a search being made in the neighbourhood, another opening of corresponding appearance, or the plane orifice of a sandy cylinder, will frequently be found within a short distance. Here is the dwelling of the *Terebella*, an edifice constructed by itself. If the finder endeavours to pull forth the tube with its tenant, the fragile structure ruptures in his hand, and the animal retreats below; but on tracing its direction as it winds a foot or more among the sand, or descends under one of the firmest stones in the vicinity, he may discover the orifice on the opposite

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side, and the whole may be removed entire, along with the architect, which meanwhile has contracted itself within the smallest possible space.

The *Terebella*, when taken from its tube, is found to be an Annelide 7 or 8 inches long, consisting of numerous segments tapering towards the posterior extremity (Pl. VI. fig. 1). Sixteen retractile pencils, each consisting of fifteen or twenty bristles, border the sides of the upper segments, but farther down these degenerate into mere stumps.

The anterior part of the body consists of a kind of frill divided into three portions, surrounding the roots of sixty, seventy, or a hundred tentacula, according to the age or dimensions of the specimen, with the mouth, which somewhat resembles a scoop, in the midst of them. Immediately behind this frill, three pairs of most beautiful scarlet tufts (the branchiæ) rise to the height of half an inch.

The animal is universally of a peach-blossom colour, with a broad, taper, smooth, bright carmine stripe descending along the belly.

If a specimen be dislodged from its tube, it swims by violent contortions in the water, after the manner of various other marine Annelidans; the tentacula and the branchiæ are compressed and contracted about the head like a brush, and, as the animal becomes very soon exhausted by such unnatural exertions, it soon sinks to the bottom. Should a quantity of sand be now scattered from above, the tentacula, speedily relaxing, extend themselves in all directions to gather it up, sweeping the vessel quite clean; so that in a very short time not a particle is

left behind that is within their reach, the whole having been collected to be employed in the construction of a new artificial dwelling adapted to shelter the naked body of the architect.

The artifice, the selection of materials, and the expedition exhibited by this creature in the manufacture of its new abode, are truly admirable; nor is it a small gratification to the curious that these may be witnessed with the utmost facility.

We will suppose a tube to have been partially constructed at the side of the aquarium, wherein a specimen is about to take up its permanent abode. During the earlier part of the day the animal is found lurking in its interior, with only the extremities of the tentacula protruding beyond the orifice, and so it will remain till towards noon. But scarcely has the sun passed the meridian, than the creature begins to become restless, and towards four or five it will be seen to have risen upwards, the tentacula extending with the approach of evening until after sunset, when they are in full activity. They are now spread out from the orifice of the tube like so many slender cords—each seizes on one or more grains of sand, and drags its burden to the summit of the tube, there to be employed according to the service required. Should any of the tentacula slip their hold, the same organs are again employed to search eagerly for the lost particle of sand, which is again seized and dragged towards its destination.

Such operations are protracted during several hours, though so gradually as to be apparently of little effect; nevertheless, on resuming inspection next morning, a

surprising elongation of the tube will be discovered; or perhaps, instead of a simple accession to its walls, the orifice will be surrounded by forking threads of sandy particles agglutinated together.

The architect has now retired to repose; but, as evening comes, its activity is renewed, and against sunrise a further prolongation has augmented the extent of its dwelling.

At first sight the numerous tentacula seem only so many long cylindrical fleshy threads of infinite flexibility. On examining them, however, more attentively, we see, that in exercising their special function, the surface which is applied to the foreign objects becomes flattened into twice or thrice its ordinary diameter; and, while conveying the sandy materials to the tube, these are seized and retained in a deep groove, which almost resembles a slit; in fact, the tentaculum becomes a flat, narrow riband, folding longitudinally in different places to hold the particles securely*.

* In *Terebella nebulosa*, writes Dr. Williams, the tentacula consist of hollow, flattened, tubular filaments, furnished with strong muscular parietes, each tentacle forming a band which may be rolled longitudinally into a cylindrical form, so as to enclose a hollow cylindrical space, if the two edges of the band meet, or a semicylindrical space, if they imperfectly meet. This inimitable mechanism enables each filament to take up and firmly grasp, *at any point of its length*, a molecule of sand, or, if placed in a linear series, *a row* of molecules. But so perfect is the disposition of the muscular fibres at the extreme free end of each filament, that it is gifted with the twofold power of acting on the sucking and the muscular principle. When the tentacle is about to seize an object, the extremity is drawn in, in consequence of the sudden reflux of fluid in its

Although these organs when contracted are collected into a brush scarcely double the thickness of the animal's body, so enormous is their extensibility, that they can be stretched out to the length of four inches, or half the length of the body, thus sweeping the area of a circle eight inches in diameter.

A thin internal coating, resembling silk, lines the whole tube, and at the same time serves as a real cement to unite and strengthen its innumerable parts. This silk-like material is derived from a glutinous slime which exudes from the surface of the body of the Terebella.

Notwithstanding the unrivalled expertness and expedition with which this Annelidan advances its work, it has never been observed to resume possession of its tube when once forsaken. To obtain the shelter of a new dwelling in place of the old, its labours are invariably recommenced from the foundation.

Observation does not seem to have supported any conjectures relative to the food of the Terebellæ. All of them appear to reject animal substances, so that perhaps, like other genera, they may derive their subsistence from swallowing sandy or earthy matter, mixed up with organized particles. The timidity of these worms would appear to prevent the possibility

hollow interior; by this movement a cup-shaped cavity is formed, in which the object is securely held by atmospheric pressure; this power is, however, immediately aided by the contraction of the circular muscular fibres. Such, then, are the marvellous instruments by which these peaceful worms construct their habitation, and probably sweep their vicinity for food.

of their attempting the capture of living prey: they seem always readier to retreat than to advance, so that the smallest and most defenceless creature might apparently easily repel their attacks.

Mutilation of the body is often produced by the violent contortions of the Terebella when removed from its tube. The tentacula also are frequently broken off, either by force or accident; yet even when thus separated they continue for a long time to give indications of vitality, and the animal seems so little affected by the occurrence, that its labours are not only continued, but commenced under such privations; nevertheless slight injuries often prove fatal, especially in hot weather. Whenever the body acquires a greenish tinge, all attempts at preserving the specimen may be considered hopeless.

The branchiæ of the Terebella are exceedingly beautiful: in the species under consideration they are so complex and luxuriant; they abound in such numerous points, angles and curvatures; their shades and intensity of colour, and the alternations of their shape are so variable, that few objects are more elegant or more interesting to behold, or more difficult to render intelligible by description; suffice it to say, that during the life of the animal, the motion, the enlargement, the reduction and spiral twisting of these branchiæ, singly or collectively, are perpetual; but the instant cessation of these movements, followed by speedy disfiguration and decay, are concomitant on the death of the animal.

The eggs of the Terebella are found enclosed in a gelatinous mass, generally fixed to the entrance of the

tube constructed by the parent Annelide; they are of a rusty-yellow colour, and when once recognized are easily procurable for the purposes of the vivarium.

These worms usually lay their eggs during the months of March and April; but this is a rule by no means of stringent application. The embryos derived from these eggs, when first hatched, give no indication whatever of the form they will subsequently assume, and might easily at first be mistaken for the larvæ of Zoophytes or of Medusæ, which they exactly resemble as they swim rapidly about by means of innumerable cilia distributed over the surface of their almost microscopic bodies; but they are not long in revealing their real nature. They soon appear perceptibly elongated, and something like a head and tail becomes distinguishable, the former being recognized by the presence of a pair of eyes resembling bright red specks.

The progress towards a worm-like form now rapidly advances, and the body becomes distinctly divisible into four zones or segments; in front there is a semicircular flattened head bearing the eye-spots; to this succeeds a broad segment covered with cilia, that still constitute the locomotive apparatus; then a narrow segment devoid of cilia; and, lastly, the tail or terminal segment, which is densely ciliated.

In the course of a short time a fifth segment is seen gradually making its appearance in the shape of a narrow ring, interposed between the *terminal segment and the last segment but one* of the larva above described. We beg the reader's special attention to the circumstance here marked in italics, for until

recently, a greater puzzle than the manner in which the Annelidans grow by the acquirement of additional segments could scarcely have been propounded.

At this period of their growth the little larvæ are quite transparent, and although no muscular fibre is as yet distinguishable in their composition, they exhibit extraordinary powers of contraction, and keep constantly changing into all sorts of shapes: sometimes they shrink into a round ball, sometimes they spread into a round disc with ciliated margins, or constricting themselves into a worm-like form, they attach themselves to the surrounding mucus, from which they have as yet hardly escaped.

The little Terebellæ, having gone through these preparatory changes, now begin to grow rapidly, and their shape becomes more vermiform, by the addition of new segments, which are progressively developed. These rings invariably make their appearance one after another, in the same way as the first-formed segment alluded to above, that is to say, between the tail-segment and that immediately preceding it; consequently, with the exception of the tail, the position of the different rings or segments corresponds exactly with their respective ages, those nearest the head being the oldest, those nearest the tail the most recently developed.

As yet, the young worm has been completely footless, but now the lateral locomotive appendages begin to make their appearance in the shape of bunches of hairs, supported on fleshy tubercles appended to the sides of the individual segments, the development of these rudimentary legs being effected in precisely the

same order as that of the rings, namely from behind forwards.

It would be tedious to follow hour by hour the growth of these young Terebellæ; suffice it to glance at the condition in which they are found when just about to leave the gelatinous mass in which they have been nursed during the first period of their existence, that is, at the end of the third or fourth day from the birth, at which time they are strong enough to issue forth and begin the world for themselves.

At this period they present the appearance of minute worms, not more than one-twelfth of an inch in length. The head is distinctly formed, and provided with a pair of eyes. The part of the body immediately behind the head, which at first was without any trace of division, and covered with vibratile cilia, seems now to represent three rings, of which only the anterior is ciliated, and the two posterior devoid of any appendages. The four or five segments which come next are each furnished with a pair of fleshy tubercles supporting setæ, and to these succeed two or three rings as yet devoid of appendages; while the tail or last segment, still densely ciliated, has undergone little or no change.

As growth goes on, the number of segments increases, and they are all provided with locomotive oars in the shape of setiferous appendages. The Terebella in this condition exactly resembles one of the erratic Annelidans, and has not the slightest resemblance to a tube-inhabiting worm, such as it will afterwards become; in short, it is provided with a distinct

head, antennæ, eyes, and locomotive feet, wherewith it swims about wherever it thinks proper; whereas the adult Terebella, the resident in the tube, has neither head nor eyes, nor antennæ; and, as for its feet, they are little better than hooks, wherewith it moves about in the interior of its beautifully constructed tube. The further progress of development is therefore rather retrograde than otherwise, the worm becoming deprived of privileges which it previously possessed. Wonderful are the means whereby the ends of nature are thus accomplished: the Terebellæ, as such, must always have remained fixed in the same locality, without the power of distributing their species beyond the spot where they have ensconced themselves; but as it is, the wandering larva roams from coast to coast in search of a resting-place adapted to its peculiar habits.

By degrees, however, the erratic habits of our little worms are put a stop to; they lose their ciliated belts, and cease to swim, content to lead during the remainder of their lives a sedentary existence. The first indication of this change is the exudation of a kind of mucus, which solidifies around their bodies, and soon forms a tube open at both ends—prehensile hooklets begin to make their appearance, supplanting the functions of the swimming feet—and the tentacula of the Terebella begin to sprout from the forehead—the eyes disappear, or rather, strange to say, become replaced by others of a different kind—the gills or branchial tufts begin to sprout from the neck, the number of segments goes on increasing, and the tube-building Terebella, at last complete in all its

parts, prepares to lay its eggs, and thus to perpetuate wonders such as those we have been witnessing.

TEREBELLA FIGULUS. *"The Potter."*

Another species of *Terebella* met with on our coasts is generally called "The Potter," and is recognizable from the preceding by the great length of the cephalic tentacula, as also from the circumstance that, in fabricating its dwelling, it gives an evident preference to mud as the most suitable material.

If the *Terebella figulus* be dislodged from its tube, the body becomes closely coiled up; but the tentacula speedily begin to search round, sweeping up everything within their reach, and, if the materials are abundant, a covering is speedily formed. Like the former, after the temporary repose of the morning, its restlessness is displayed through much of the day, and becomes augmented as evening approaches. At this period an active search for building-materials begins. Some tentacula secure particles of mud, others are withdrawing grains of sand, and several seize on shelly fragments. Much industry is manifested, and all these various collections are gradually brought in by the contraction of the respective organs retaining them. While the tentacula are thus employed, an undulatory action, like repeated inflation of the upper part of the body, is repeated fifteen or twenty times in a minute, the movement advancing in an upward direction, as towards the orifice of the tube. Next, ten or twelve particles are discharged, perhaps from the mouth, after having undergone

some previous preparation there, and these are added to the circumference of the orifice of the tube. The under-lip then seems occupied in smoothing the newly-added portion up and down, or possibly cementing it to the rest with glutinous matter.

It seems beyond a doubt that the materials employed in building are first swallowed.

The tentacula of the *Terebella figulus* seem to vary in number from twenty-five to fifty; they are stouter than those of the preceding species, and, when completely extended, they measure at least nine inches, that is, above twice the length of the body of the animal, so that they are thus capable of sweeping over a very spacious area. Their natural colour is uniformly brown, or tending to carmine; but when stretching far, they resemble strong whitish horse-hair.

Nothing is more surprising than the attention of so humble an artist being directed towards such a variety of operations at the same moment. Many tentacula are engaged in searching after the materials —many in collecting them—whilst others are bearing them towards the edifice; some are quitting their hold, while others are recovering a load that they have let fall, the architect itself being all the time busily employed in kneading masses in its mouth, disgorging them successively in proper situations, or in polishing the rude workmanship resulting from its labours.

A perfect tube is half an inch in its external diameter, the sides being of considerable thickness, so that it has the appearance of being massive and clumsy; nevertheless, it is in reality so fragile as to be incapable of sustaining its own weight, on which

account it is often constructed horizontally, or built against some foreign substance for support.

Some of the Terebellæ, more especially the species under consideration, are endowed with the faculty of emitting a brilliant phosphorescence, but it is rarely displayed.

When this occurs, it is apparently the result of restraint or suffering. Flashes were emitted by a small specimen which had left its tube, on transferring it to a different vessel: on replenishing the latter with water, a most copious bright blue refulgence, intermingled with a reddish flame, streamed from the tentacula and other organs. Apparently the phosphorescent property is diffused over the body, and in the case above mentioned the coruscations evidently attended violence.

Terebella conchilega. "*The Shell-binder.*"

A third species of *Terebella*, the Terebella conchilega, or Shell-binder, is another beautiful and interesting inhabitant of the aquarium. This elegant Annelide, as its name imports, constructs a dwelling exclusively of comminuted shell, in preference to all other materials. In the natural state it generally takes shelter within some capacious empty shell, such as a valve of the *Venus islandica*, there to establish its edifice. On all occasions this tube is formed of irregular and unequal fragments, and lined with a silk-like exudation from the body of the animal.

This Terebella may be induced to exercise its architectural faculties by diminishing the light during the

day, as if night were approaching. If supplied with different-coloured fragments of shell, a variegated tube in bands, or otherwise constructed, may be obtained. A beautiful edifice is composed of the shivered pearly internal strata of oyster-shells: and a specimen having been dislodged from its tube, and committed to a vessel containing a few shelly fragments, some sand, and a number of small Venetian beads, has been known to employ them all indiscriminately in the fabrication of a new dwelling. In default of comminuted shell, the *Terebella conchilega* will build a tube exclusively of sand.

By eliciting the propensities of this animal, the observer may have much agreeable and interesting entertainment.

If dislodged from its tube, and placed in a vessel of sea-water, the Terebella profits by the earliest provision of fresh materials to construct another. While this is conducted up the side of the vessel, the tentacula, those essential mechanical auxiliaries, are busily employed. A silky tentaculum seizes a fragment to be elevated to the orifice; it is too ponderous and unwieldy, and two or three other tentacula then unite their efforts in raising the load to its intended position. An empty mussel-shell, about half an inch long, was thus elevated and secured in its place, to augment an edifice in progress.

Great expedition is exhibited in fabricating a tube solely of sand, under a total deficiency of more favourite materials, and heavy loads of it are dragged towards its naked body, with which the mouth is speedily occupied; but shell is best adapted to the

labours of this architect, and always receives a decided preference. Some particles of this material are certainly swallowed preparatory to their being incorporated with the edifice; but, from the dimensions of others, it is evident that they must be fixed in their places by means of some kind of adhesive matter. When closely examined, the whole structure evidently consists of a very tough silk, covered with fragments of shell.

Specimens of this Terebella have survived nine months in confinement.

On some shores the *Terebella conchilega* is the most abundant of all the larger Annelides, with the exception of the Arenicola. They are most numerous about midway between high and low water-mark, where the sand is mixed with a large proportion of stones. By the shifting of the sand in storms they are often buried to a considerable depth, and at other times have several inches of their tube exposed. In the first case they speedily work up to the surface; in the other the exposed portion of the tube is soon broken off by the waves, or crumbles from exposure to the sun. Their tubes are very long, and the animal remains towards the bottom, except when seeking for food. Hence specimens are to be obtained only in favourable situations, for it is almost impossible to dig up the whole fabric.

As soon as the Terebella is removed from its case, it throws itself into spiral folds. If now it is placed under water upon sand, it forthwith straightens the body, and presently all the tentacula are seen in full action. They are extended in every direction, often

to a length exceeding an inch and a half; and they are soon seen dragging in small fragments of shells and the larger particles of sand. These it places behind the scales which project from the anterior and lower part of its head, where they are immediately cemented together by a gluten which exudes from the animal. Bending the head from side to side while it continues to apply the materials of its tube, the Terebella very soon has formed a complete collar, which it employs itself in lengthening regularly from every part of its circumference, with a persevering activity highly interesting to behold. In order to fix the fragments compactly, it presses them into their places with the erected scales, at the same time slightly retracting its body. Hence the fragments, being raised by the scales, are generally fixed by their posterior edges, and thus overlaying each other, often give the tube an imbricated appearance.

When the tube is from half an inch to an inch in length, the animal proceeds to burrow. Directing its head against the sand, it slowly penetrates it. The penetrating force is very inconsiderable, because the creature, having to form its case as it descends, can advance but slowly. It is now of course obliged to avail itself of the materials with which it may come in contact. Its progress is marked by the gradual disappearance of the tail, which continues to withdraw into the tube till the whole has entered. Soon afterwards the *conchilega* is found to have turned in its abode, and its head appears at the surface.

In summer the whole task is completed in four or five hours; but in cold weather, when the animals are

more sluggish, and the gluten appears to be secreted in smaller quantities, their progress is slower in proportion.

The extremity of the tube, which appears at the surface of the sand, is generally ornamented with a number of branches composed of single rows of sandy or shelly particles. These are formed accidentally from time to time by the adhesion of sand to the tentacula when thrown out in quest of prey. The gluten exuding from the tentacula cements the grains of sand together, as may be plainly seen in animals kept in confinement.

Terebella textrix. "*The Weaver.*"

The species thus named by Sir J. Dalyell is of very small size, varying from about an inch to an inch and a half in length. It constructs a semicylindrical sheath of sandy or muddy particles, the dimensions of which are always insufficient to cover the body or to receive the head; and this sheath is frequently abandoned, and as often resumed; neither does the animal restrict itself to the construction of one sheath only.

The most peculiar feature, however, in its history is, that it manufactures a real cobweb, as distinct as that of the spider, with which it covers itself, and which also frequently, if not always, serves to support its spawn. The texture of this remarkable web is very thin, rather irregular, and composed of threads so fine that they are almost invisible, from their slenderness and extreme transparency. Neither the mode of formation or extension, nor the expedients

used for fastening this web, are at all obvious. This is, however, plainly a work of some exertion, as the threads, sometimes amounting to fifty, are fixed to the side of the vessel as high above the bottom as equals the length of the "Weaver" or more, and they also extend below, there to be secured. Thus it is evidently an artificial work, and it receives successive additions.

Such a web, however, seems only to be constructed during the month of May, and appears specially destined to the reception of the eggs, which about this time are deposited.

AMPHITRITE OSTREARIA. *"The Oyster Amphitrite."*

The word *Terebella*, literally translated, would seem to signify a creature endowed with the faculty of perforating rocks and other hard substances, a name by no means applicable to the animals we have been describing under that appellation. Nevertheless, there is one exception to be found in a very small Annelidan, bearing some remote kindred to the Terebella, which seems to have the power of excavating a burrow for its own lodgement, even in so hard a substance as shell.

While inspecting the exterior of old oyster-shells, the observer may sometimes see several slender, brownish tentacular organs playing around a fixed point, and occasionally withdrawing themselves from view. On separation of the laminæ and breaking down the shell, an Annelide, from which they proceeded, is discovered lurking in a cavity in the midst of its solid substance.

In some respects this animal bears considerable analogy to the Terebella. The body of the little parasite is about nine lines in length, composed of numerous segments, and tapering towards each extremity; it is bordered throughout with a row of pencils, composed of three or four setæ each. The mouth is a cavity in the anterior extremity, somewhat behind which are eight round flexible tentacular organs situated on the neck; these are susceptible of being flattened and folded longitudinally, like the tentacula of the Terebella. Eight of these tentacles would seem to form the complete apparatus, and they are possibly developed in succession, seeing that specimens two lines in length have only a single pair.

The special habitation of this creature is a cavity adapted to its size, often situated in the thickest part of the shell. The cavity is lined with silk, and therein the tenant lurks, protruding its tentacula through a circular aperture; these are always employed in searching round the vicinity, like those of the Terebellæ proper.

Although not dwelling in society, several of these worms may often be found within narrow limits. At least a dozen have been seen displaying their tentacula from the surface of a single shell; besides which there were probably others of small dimensions obscured by adventitious matter.

CHAPTER XXXII.

NEREIDES.

"I would not enter on my list of friends,
Though graced with polish'd manners and fine sense,
The man, who needlessly sets foot upon a worm."

COWPER.

IT certainly is a circumstance much to be regretted, that the poets, both ancient and modern, when wishing to indulge in flights of fancy, by describing monsters and all sorts of prodigies, have never come to Nature herself for a few lessons, or at least for a few hints upon which they might have improved. Take them altogether, they are a very timid race, and their best fictions so infinitely below reality, that they ought to be ashamed of themselves. When our late respected friend Dr. Mantell discovered the "land of the Iguanodon," he went the right way to work. First, he reintegrated the great forms whose bones he had exhumed, and with the data thus before him, applied to the genius of John Martin to poetize the subject. The result was most satisfactory: the mighty reptile stood at once, as terrible in aspect as if all the poets of antiquity had had the making of him; bestriding acres of ground, his length of tail curling off towards the horizon till lost in aërial perspective,

and evidently requiring a good Dollond's telescope to see the end of it. The poetical brood of dragons, griffins, basilisks, hide their diminished heads in presence of their mighty prototypes, at present "revisiting the glimpses of the moon" before the Crystal Palace; and we rather think that Apollo would hardly have wasted his arrows upon the fabled Python had he seen the original owners of some bones that now figure in geological cabinets.

The truth is, we fear, that poets are by far too diffident, and, in their over-anxiety not to

> "o'erstep the modesty of nature,"

that they come very much short of the license which creation fairly gives them: were it not so, we suspect they would at least indulge us with greater variety. They have not as yet, we can assure them, exhausted the catalogue of things new and strange actually in existence, monsters more terrible

> "than fables yet have feign'd, or fear conceived,
> Gorgons, or Hydras, or Chimæras dire."

Fortunate is it for this world that the tyrants of our modern seas are most of them comparatively of very limited dimensions; else we could point out some, which we believe Perseus himself, backed by his Pegasus,—or rather backing his Pegasus, as we ought to say,—would hardly like to encounter, even were it to free another Andromeda. Neither need we go far to find them; the NEREIDS upon our own coasts, could we but procure an Ovid to chronicle their exploits, would furnish a history far more wonderful than any of all his mythological outrages upon the laws of

natural history; and as for metamorphoses, the zoologist could supply him to his heart's content. However, poetry is not our province; we must return to the broad beaten track of truthful narrative, and introduce the Nereids to the reader, such as he will find them in his own aquarium.

The body of these worms (Pl. VI. fig. 7) consists of a consecutive series of rings, all of which, with the exception of the anterior segments, that constitute the head, seem to be repetitions of each other, only differing in size as they taper gradually towards the tail. Upon every one of these rings several external appendages are observable, situated on each side of the body. The uppermost of these appendages is frequently a tuft of branching filaments, of a bright red or crimson colour in the living animal; in other cases it consists of a single stem, to which lateral filaments are attached; or else in some species these organs consist of mere flattened lamellæ, formed by processes of the skin; but whatever may be the shape of these appendages, their nature and office are the same; they are almost entirely made up of the ramifications of bloodvessels, and being constantly immersed in the surrounding water, the blood flowing through them is effectually exposed to the influence of the air contained therein, and respiration thus adequately provided for. These tufts therefore constitute so many pairs of gills or branchiæ, and from the circumstance of their being situated upon or near the back of the animal, this group of Annelidans is distinguished by the name of Dorsibranchiate (*dorsum*, the back, and *branchia*, a gill).

The other appendages to each segment are subservient to locomotion, and are called the *oars*; these are generally two in number, upon each side, one being situated near the back, and the other upon the ventral aspect of the body: the two pairs of oars are generally separated from each other by a wide interval, but occasionally they are so nearly approximated as not to be readily distinguishable; or there are instances in which only one pair is developed. When perfectly formed, each oar is found to consist of a strong fleshy pedicle, from which there projects an appendage called the *cirrus*, which is of very different shape in different genera, sometimes being long and filiform, at others expanded into a broad paddle like that of a Sandwich Islander's canoe, or occasionally it may be very small and scarcely perceptible.

In addition to the cirrus, each fleshy pedicle is furnished with a packet of stiff hairs, which can be protruded or retracted into the body at the will of the animal; these, from their expansion, add greatly to the propelling power of the oar, and moreover sometimes constitute a most formidable apparatus of defensive weapons.

There is no want of locomotive machinery, therefore, in one of these humble-looking worms: no steamer, with its paddle-wheels at work, presents a spectacle more admirable than that offered by every segment of the *Nereis*; and when all combine to beat the waves in unison, the ease and grace with which the creature swims, or rather glides along, almost exceeds belief.

A broken specimen of one of these worms now before us, the *Eunice gigantea*, measures upwards of four feet in length, and consists of four hundred and forty-eight segments, all provided with their complement of paddles. Let the reader, therefore, imagine for one moment this gorgeous animal free in its native seas, blazing with iridescent tints that answer back again the glowing brilliancy of a tropical sun, while it rows along its "oary state" by means of upwards of seventeen hundred distinct propelling laminæ, all wielded with such energy that the eye can scarcely follow the rapidity of their movements, and then perhaps he will be able to form some idea of the efficiency of a locomotive apparatus such as is provided for these dorsibranchiate Annelidans. The fabled Orc of Ariosto, moved along

"By thousands of strange wheels and thousand slides *,"

is here outdone, and poetry lacks terms to give expression to a scene so wonderful :—

"....in such sort,
As, sped by roaring winds, long carack steers
From north or south, towards her destined port,
So the sea-monster to his food repairs †."

It is an interesting spectacle to observe one of these creatures moving about in its tank, as though indignant at captivity. Its many rings alternately contract, and again extend themselves into a spiral,

* "Con mille guizzi e mille strane ruote."

† "Come sospinto suol da Borea o d'Ostro
Venir lungo navilio a pigliar porto
Cosi ne viene al cibo che l' è mostro
La bestia orrenda."

emitting at every moment flashes of light, in which all the prismatic colours are blended in the brightest metallic reflexions. When these motions cease, it crawls along the bottom of the trough, throwing forward its thousand feet, and pushing out bundles of darts from the broad knobs that contain them. The sides of its trunk are studded with its organs of respiration, resembling vermilion plumes when they are swollen by the blood, which may be traced along the dorsal vessel. At its head, enameled by the brightest colours, are five organs of touch, encircling an irregularly-puckered mouth, from which protrudes at intervals a huge proboscis, armed with three pairs of jaws. The corselet of the brightest beetle, the bronzed wings of the butterfly, the blazing throat of the humming-bird, would all look pale when compared with the play of light flashing in large patches over the rings of its body, glowing in its golden threads, and sparkling over its amber and coral fringes.

The *Nereides* must be sought for in the excavations of rocks, in the hollows of sponges, in univalve or bivalve shells, in the interstices of the radicles of sea-weeds, under stones, or, in general, in all kinds of cracks and fissures. There are some which bury themselves in mud or sand, where they excavate a lodge proportioned to their dimensions, and sometimes they line this dwelling with a mucous material secreted in sufficient abundance to construct a tube or sheath. From this they put forth a greater or less portion of their body, but rarely the posterior extremity, so that they may be able to re-enter on

the slightest indication of danger; in this respect resembling the Sea-Nymphs, whose names they bear*, who, when upon the shore, as we are told, took up their residence in grottos and in caves adorned with shells. Widely different, however, are the voracious habits of these Annelidans from those attributed to their mild and beneficent prototypes.

The Nereids found in sand bury themselves by the same rapid undulating movements they employ in swimming, and also travel along with great facility by extending their anterior rings and bringing up the posterior part of the body, somewhat after the manner of an earthworm, their progress being at the same time very much assisted by the action of their numerous bristly feet and lateral appendages. Woe betide the victims that misfortune brings within their reach! their death is certain, though their fates may be slightly different:—

"For some the felon quarters, some he flays,
And some he swallows quick, and some he slays."

On studying still more carefully these Annelides, and using glasses of a moderate power, the hairs appended to their feet or fins, or oars (call them by

* "Away they race; and foremost of the throng,
NERINÈ, flashing onward in the pride
Of force consummate, flings herself along;
NISA goes bounding o'er the bounding tide;
DOTO, in more than wonted fury strong,
Breasts the tall billows; the curved waves divide
In awe, to give the rushing NEREIDS way:
Long lines behind them gleam of argent spray."
CAMOENS, *Lus.*

any name you please), are seen to form two tufts or sheaves of darts, sometimes combining every form of our aggressive weapons. Here are curved blades with two cutting edges, the one convex, the other concave; there are the types of the broadsword of the Highlander, the *sabre-poignard* of the artilleryman, and the *sabre-bayonnette* of the Vincennes chasseur. Elsewhere we have harpoons, fish-hooks, and cutting-blades of every shape, fixed to sharp handles, straight or curved disks, and lances with their barbs bent backwards, like the spears of Indian savages, as though to tear the wounds inflicted, but enclosed in a sheath preserving them from fracture or from friction.

These creatures, as might be expected from their activity and erratic habits, are carnivorous; and innocent and beautiful as they look, they are furnished with weapons of destruction of a unique and most curious description. The mouth of the Nereis would seem at first to be a simple opening, quite destitute of teeth; but on further examination, this aperture is found to lead into a capacious bag, the walls of which are provided with sharp horny plates, even more terrible than those which occasionally are to be met with in the gizzards of some of the higher animals. It is not surprising, therefore, that by many anatomists the structure in question has been described as a real gizzard, or by some as the stomach itself. A little attention to the habits of the living Annelide will, however, soon reveal the true character of the organ. No sooner does the creature wish to seize its food, than this so-called gizzard is at once turned inside

out, in which condition it protrudes from the mouth like a great proboscis; and the teeth, which were before concealed in the interior of the cavity, now become external, and display as formidable an assortment of rasps, files, knives, saws, hooks, or crooked fangs, as any one could wish to see. Let us suppose them, when in this condition, plunged into the body of some poor helpless victim, while at the same moment the proboscis is rapidly inverted and withdrawn; the prey thus seized is at the same instant swallowed, and at once plunged into a gulf where all struggles are unavailing, there to be bruised and crushed, and sucked at leisure.

It is, moreover, extremely probable, that creatures furnished with such tremendous teeth are not formidable to small animals only, but that, like the Lamprey, they can fasten themselves on living or dead fishes, and bore or tear their way through the skin and flesh, thus procuring a meal at the expense of the lives of their victims.

Many species of these worms appear to be entirely destitute of any visual apparatus; in others numerous minute specks are distinctly visible, which are arranged with more or less regularity upon the upper part of their head, and which, notwithstanding the simplicity of their structure, seem, in a more or less perfect manner, to perform the functions of eyes.

Those who have watched the habits of the Nereids, says Dr. Williams, will scarcely doubt that they are gifted with the power of discriminating external objects, of making towards some point, and avoiding others. In the absence, however, of such an optical

arrangement as may be fitted to collect the rays of light, it is difficult to form any conception of the nature of sight in these animals, if this endowment really is conferred upon them. Still it is not essential to the practical purposes of the lowest forms of life that the objects of the external world should be *seen*, that pictures of them should be painted upon the retina; it were enough that the mere presence or absence of an objective body should become evident to the sensations of the animal by the positiveness or negativeness of the impressions received. A refinedly exalted sense of touch would suffice to accomplish this object. It is not easy for those who have never enjoyed the spectacle of the "feat of touch," performed by the tentaculated worms, adequately to estimate the extreme acuteness of the sensibility that resides at the extremities of the living threads with which the head and sides of the body are garnished. They select, reject, move towards, and recede from, minute objects with all the precision of animals gifted with the surest eagle sight, and steer themselves harmlessly, readily, and unerringly through the thickly tangled labyrinth of mud, and stone, and gravel, and weed, amid the twilight of which the habitat of many of them may have been cast.

The same author observes, that it is a remarkable fact in the history of the free Annelidans, that scarcely any species, however organized, whether furnished or not with external locomotive organs, in its numerous and varied muscular evolutions *ever moves directly backwards*. Their movements consist always of serpentiform pranks, or those of elaborate coiling. It

is by the head, however, that such motion is invariably initiated. The tail is always in the rear, never in the van.

One of the most interesting phenomena presented by these worms is their capability of developing and detaching progeny by a kind of sprouting from the posterior end of their bodies. The part where this wonderful process takes place is invariably the same, the new animal being always formed by a vegetative growth of the antepenultimate segment, that is to say, from the segment immediately preceding the terminal one. This reproductive segment may be observed at certain periods to become slightly swollen, and evidently the seat of increased vital action; and a short time is sufficient to reveal that it is employed in manufacturing a young worm, which is soon seen growing from the hinder extremity of its parent, from which, when sufficiently complete, it detaches itself. If the head or anterior segment of the species be characterized by eye-specks, antennæ, a proboscis, or branchiæ, these are developed in the offspring or offshoot, so as to be completely recognizable before the final separation takes place; so that we have the strange spectacle of two animals, one growing by its head from the tail of the other (Pl. VI. fig. 3). And very frequently this is by no means the extent of the prodigy; for it very generally happens that as soon as the lineaments of the head of the first young one are established, the reproductive segment of the parent resumes its procreative function, and a second offspring is developed, intervening between the one first formed and the original Annelide; nay, sometimes a

second and a third are produced by a repetition of this process, so that four generations may be seen organically connected together, and constituting one individual, which, however, soon separate from each other, and thus become converted into as many distinct animals. Indeed, Professor Milne-Edwards has observed six young ones generated in succession from the same posterior segment, all of which for some time continued adherent to their parent.

The British species belonging to this family of Annelidans are very numerous; some of them are exceedingly minute, while others attain considerable dimensions: we select from among the latter a few of the most conspicuous and interesting for special notice—

"... facies non omnibus una,
Nec diversa tamen; qualem decet esset sororum."

NEREIS FULGENS. *"The Iridescent Nereis."*

The length of this elegant Nereis is about seven inches, and its breadth at the head four lines. The figure of the body is roundish, and it consists of above a hundred segments. The part representing the head is a smooth cylinder, projecting beyond the first segment of the body, furnished with eight antennular organs, and terminated by two stout conical appendages, placed widely apart, each of which is tipped with a soft spongy-looking substance. The eyes, which are blue, are four in number, set in a quadrangular form. The colour of the body is universally an orpiment or orange-red, with a darker longitudinal line

running down the back; the whole surface is finely iridescent. Two black incurving jaws are seen within the orifice of the proboscis, their extremities projecting just beyond it.

This creature constructs a very thin transparent silky tube, composed of a material, that, apparently, exudes from the whole surface of its body, wherein it keeps itself concealed, except the head, which remains exposed, and is commonly found waving from side to side. The tube is often strengthened by having sand incorporated with it, where this material is accessible; if not, it remains quite transparent. It is always formed of sufficient width to allow of the animal's reversing its position within.

The *Nereis fulgens* is a littoral species; it retreats from the light, lurking under stones or in clefts. Fine specimens may frequently be found by raising shelving portions of rock near low water.

Nereis (Nephthys) margaritacea.

The Nereis (Nephthys) margaritacea, the *Pearly Nereis*, is a magnificent species, sometimes measuring ten inches in length, and consisting, when full-grown, of upwards of a hundred and forty segments, each provided with a complete set of locomotive organs. Two short stumps are situated on the head, and a proboscis of extraordinary dimensions is occasionally darted forth. Sometimes a black speck is seen in front; but it is neither constant, nor are eyes visible. The shape of the proboscis varies considerably, but it is generally somewhat barrel-shaped, and about three-

quarters of an inch in length, by half an inch wide towards the middle; it is beset by several rows of short, spinous papillæ, placed towards the extremity, which is terminated by a circle of them. The largest row is composed of at least thirty of these dental structures. The proboscis reflects light, as though it were composed of a hard substance, which it is not; it is protruded when the animal is in a state of extreme weakness, and at length becomes incapable of being withdrawn.

The colour of this Nereis is nearly white, with a line down the middle of the back; but no figure can do justice to its beauty. It is quite possible, indeed, for a person to study these elegant creatures in engravings, and thus imagine that he has acquired a tolerably exact idea of their structure, without having the slightest conception of the interest which attaches to an inspection of their living forms and active evolutions.

The *Nereis margaritacea* swims by a serpentine motion, in a horizontal direction, with great violence and rapidity. When at rest, it lies among the sand close at the bottom of the vessel, with its head partially protruded. It is extremely timid, and, if near the top of the tank, retreats downwards upon the slightest alarm. If its site is about to become dry, the body twists, as if preparing to leap.

This animal frequents the sands of the sea-shore somewhat lower than the point of half-tide.

PHYLLODOCE LAMINOSA. "*Laminated Nereis.*"

But the most magnificent Nereis inhabiting our

seas is the NEREIS REMEX, or, as it is now called, the PHYLLODOCE LAMINOSA (Pl. VI. fig. 7). The length of this glorious Annelide is sometimes at least two feet, and its body composed of above 400 segments, always multiplying with age, each segment being provided with a pair of broad lateral paddles, by the aid of which it swims through the water with indescribable elegance. The natural colour of this gem of the sea is a fine green: bluish green on the centre of the back, iridescent, reflecting a bright blue; while the paddles, as they are justly denominated, are always green.

During the day this species lurks in concealment, mostly under some large flat shell, where it reposes; but at night it unfolds itself from its many convolutions, and goes in quest of prey. In confinement, however, it seems to refuse all kinds of sustenance, and becomes at length lank and emaciated, from protracted abstinence.

The mechanism of this creature, its parts, and their powers, are to be ranked among the more conspicuous and admirable works of Creation; nor can they be contemplated without wonder. Issuing forth from its retreat, it swims by an undulating serpentine motion. Its unwieldy body, gradually withdrawn from its hiding-place, has its multiplied organs unfolded in regular order and arrangement; so that, whether intertwined or free, they never present any appearance of intricacy or confusion—each part performs its own proper functions, and the general effect is produced by the united exercise of the whole. When inactive, the lateral paddles are laid close over the

back; but when in activity, they spread widely out, acting like so many oars to aid the animal's course by their successive impulses on the water. It is a pleasant thing to see a well-manned boat glide over the smooth surface of the sea—to watch the long array of oars as silently they simultaneously dip and rise again, all flashing in the evening sunshine; but such a sight is but a paltry spectacle compared with that afforded by these gorgeous worms—400 pairs of oars, instinct with life, harmoniously respond in play so active that the eye can scarcely trace their movements, save by the hues of iridescent splendour, violet and blue, and green and gold, the very rainbow's tints, that indicate their course.

In confinement, these magnificent Nereids can seldom be preserved entire. Their body, unmanageable on account of its length, without ample space wherein to perform its evolutions, is exposed to frequent entanglement amongst surrounding objects, and is often broken by the creature's struggles to get free; yet, wonderful to state! even this is by no means an irreparable damage. A specimen kept by Sir John Dalyell, measuring about twenty-two inches in length, was mutilated by the loss of some of the hinder segments of its body during the month of October, and in eleven days the wanting joints had been regenerated. But on the 22nd of January the body of the same worm broke asunder near the middle. Within three weeks the wound at the hinder extremity of the anterior portion healed, and in the month of April above fifty segments with their paddles had been reproduced. The whole of the newly-formed

portion was of a pale green colour, but its breadth did not exceed a third of the width of the original.

It seems, however, that it is only the anterior portion of the Phyllodoce which possesses the power of regenerating lost segments, although the hinder parts retain their vitality for an extraordinary length of time. In the specimen above mentioned, the posterior half, when detached from the rest of the body, had had a small fragment torn off, leaving the place ragged; this ragged end Sir John Dalyell removed with a sharp pair of scissors, in hopes of preserving it. Accordingly the result was that the wound healed in eleven days; but, after fifty days had elapsed, nothing indicated regeneration of the defective head, and about a month later both parts unfortunately perished from accidental vitiation of the water.

A month subsequent to the capture of several specimens of these animals, a green globular mass, above five lines in diameter, made its appearance floating in the vivarium wherein they were confined; it was attached slightly to a very thin silken tube formed on the side of the vessel near the surface of the water, and had doubtless been deposited by one of them, which kept always in the vicinity. This globular mass consisted of hundreds of eggs resembling green specks imbedded in a transparent jelly. After a few days, these eggs were hatched, and gave birth to minute ciliated embryos, which for several days moved rapidly about in the surrounding water, testifying by their numbers the extraordinary fertility with which these creatures are endowed; for Nature still continues to pour forth with lavish hand immense supplies

of creatures such as these, to be alternately destroyers and destroyed:—

"While ravening death of slaughter ne'er grows weary,
Life multiplies the immortal meal as fast.
All are devourers, all in turn devour'd;
Yet every unit in the uncounted sum
Of victims has its share of bliss—its pang,
And but a pang, of dissolution: each
Is happy till its moment comes; and then,
Its first, last suffering, unforeseen, unfear'd,
Ends with one struggle pain and life for ever."

NEREIS NOCTILUCA. *"The Glow-worm Nereis."*

Among the members of the numerous tribe of Nereids, we must not forget to mention the luminous properties of the NEREIS NOCTILUCA:—

"Hanno quest 'onde i lor diletti ancore
Qui se spiega la notte il fosco velo
Nel mare emulo al cielo;
Piu lucidi, piu belle
Moltiplicon le stelle
E per l' onde vedrai gelida e bruna
Rompere i raggi e scintillar la luna."

When transferred amidst a quantity of marine productions to a glass jar, this pretty little Annelide, a diminutive species not exceeding the length of half an inch, commonly ascends to the very edge of the water, and there secures itself just under the surface, in a silken sheath applied to the side of the vessel. On sudden agitation, the whole body of the worm seems in a blaze, even while it remains stationary in its own element; but if, after emptying the vessel, it is filled up with *fresh* water (*i. e.* river-water), beautiful

flashes are emitted; and should different parts of the sides of the vivarium be occupied by several specimens, as is always the case where miscellaneous collections have been recently introduced, so many brilliant coruscations will escape from all the parts of the vessel where they are established. This interesting, though rude experiment, may be repeated several times upon the same subjects; however, if these are to be preserved, the vessel must be speedily drained and refilled with their proper element, as few marine animals can survive even a short immersion in fresh water.

The *Nereis noctiluca* is at all times an elegant and instructive little creature, serving at least to show what various forms of life Nature has lighted up to beautify the deep,

> "Or gild the surge with insect sparks that swarm
> Round the bright oar."

We have yet to discuss one of the most interesting departments connected with the history of the Nereides, namely the metamorphoses which these creatures undergo after leaving the egg, and their subsequent growth to their mature condition,—subjects which, to every aquariist, present a rich field for observation and research.

We need hardly say, that the Nereis, in the earlier stages of its growth, does not as yet possess the almost countless segments that it afterwards acquires; and yet the mode in which those segments become multiplied, and, as they grow, provided with the complicated limbs they sometimes bear, was, until recently, a most unfathomable mystery.

The Nereis, when it leaves the egg, is quite a limb-

less embryo (Pl. VI. fig. 7, *a*), and might be taken for an Infusorial form of life, swimming about by means of a broad ciliated disk. How long the microscopic atom keeps this shape we know not, nor the mode in which it is transformed into the second aspect under which it shows itself (Pl. VI. fig. 7, *b*), in which condition it is recognizable under a figure somewhat like its proper self, about a line in length, offering as yet only four segments bearing lateral oars, although its head and eyes are quite discernible, as well as one small pair of antennæ.

As growth advances, other segments show themselves successively, and these are always found to be developed in one spot, namely between the last-formed segment and the tail, or rather the tail-bearing ring which terminates the body; and as they by degrees are perfected, they develope from their sides the lateral oars, which now become the locomotive agents, and the creature gradually attains the appearance seen in the next figure (Pl. VI. fig. 7, *c*).

By constant repetitions of the same procedure, more segments and more oars progressively are added from behind to those in front (Pl. VI. fig. 7, *d*), until the animal, at length promoted to its perfect form, continues to grow longer as new segments show themselves, till it acquires the complement allowed by Nature in its adult state.

Such is, in brief, an outline of the process; but there yet remains wide scope for any one, whose leisure or whose opportunity affords the means of adding to our knowledge on a subject so important, and as yet almost in its infancy.

CHAPTER XXXIII.

CIRRATULUS BOREALIS—"THE NORTHERN CIRRATULUS."

THE length of this beautiful Annelide (Pl. VI. fig. 4) is about four inches; its body is composed of numerous segments tapering towards each extremity; but the most striking feature whereby it is distinguished consists in the possession of numerous long and flexible *cirrhi*, or thread-like appendages, made up of an infinite number of rings attached along the entire length of its body.

These cirrhi, apparently

> "More soft and sensible
> Than are the tender horns of cockled snails,"

arise on each side from every alternate segment of the body, and besides being instruments of prehension, apparently perform the functions of the branchiæ or breathing organs of other Annelidans. They run in two rows down the back, and are continued nearly to the posterior extremity; they are longest, however, in the vicinity of the head, becoming gradually shorter as they recede backwards. When the animal crawls, these cirrhi lie along the back, presenting a very singular appearance.

The colour of the Cirratulus is generally red, some-

times tolerably vivid; or it is brownish or variegated, owing to the quantity of mud which the worm swallows, apparently as its ordinary diet.

Through its long filamentous arms and branchiæ the blood ebbs and flows, dyeing them of the richest crimson, or leaving them of a faint yellow colour. The tangled skein which they have formed consists of living coils, ever binding and unbinding their glistening knots, and catching up grains of sand, or atoms of slime, till the animal retires into an envelope of fragments, which, by clustering together, become a case, which encloses and protects it.

The natural and favourite habitat of these Annelides is in the muddy fissures of rocks, or under tufts of sea-weed or other soft covering, and they are generally met with considerably above low-water mark. They are distributed very profusely upon most shores, but are never to be found amongst sand. While the animal lurks in its retreat, its cirrhi are spread like so many worms over the neighbouring surface.

The Cirratulus retires from the light. If kept in a white saucer covered with a shell or stone, it will creep out at night; or by filling the vessel containing it to such a height that the tips of the cirrhi cannot reach the surface of the water, it will abandon its concealment and crawl up the side, thus affording a satisfactory view of its structure; but, when forcibly removed, the whole creature contracts into a confused bunch.

The Cirratulus lays its eggs during the months of May and June: the ova are very numerous, minute.

and of a spherical shape. When hatched, the embryos have exactly the appearance of Infusorial animalcules; in form they are elongated, flattened, and begirt with cilia; their length three times their breadth; their colour a faint dingy yellow; their body generally opaque, but with lighter portions on some specimens. Their movements towards the end of June become rather slow, and sometimes the little creatures display a tendency to revolve horizontally on the centre of the body as on an axis. The further development of these embryos has not as yet been satisfactorily traced.

The Cirratulus is tolerably patient under confinement: one specimen survived eighteen months, and then it perished accidentally.

CHAPTER XXXIV.

APHRODITE ACULEATA.

"Quell' era armata di piu fin metallo
Ch' avean di piu color gemme distinto;
Rubin vermiglio, crisolito giallo,
Verde smeralda, col flavo jacinto."

ARIOSTO, *Orl. Fur.*

"Of metal was her armour bright,
With gems of many colours overspread;
The tawny jacinth, yellow chrysolite,
The emerald green of hue and ruby red."

THE aspect of the *Aphrodite aculeata* (Pl. VI. fig. 5) is so peculiar that it cannot be mistaken. It is the most brilliant of all the lower animals inhabiting the seas of the British coasts, and has consequently invariably attracted the notice of many who have not otherwise much curiosity regarding the works of creation.

The body of the largest is sometimes as much as eight inches in length; commonly, however, it does not exceed five, and is of a long oval figure, with extremities proportionably acute. The back is somewhat convex, the belly flat; a short, thick, brown fur covers the dorsal region, especially towards the sides, interspersed with long bright green and yellow iridescent hair; and intermixed with this are transverse

irregular rows of long, stiff, thorny, brown bristles. Nothing can exceed the splendour of the colours which ornament these apparently apathetic beings; they yield indeed in no respect to the most gorgeous tints of tropical birds, or to the brilliant decorations of insects: green, yellow and orange, blue, purple and scarlet—all the hues of Iris play upon them with the changing light, and shine with a metallic effulgence only comparable to that which adorns the breast of the humming-bird.

But it is not for their dazzling beauty merely that the setæ of the Aphrodite are remarkable; they are not unfrequently important weapons of defence, and exhibit a complexity of structure far beyond anything to be met with in the hairs of higher animals. In the *Aphrodite hispida* they are perfect harpoons, the point of each being provided with a double series of strong barbs; so that when the creature erects its bristles, much more formidable than those of the porcupine, the most determined enemy would scarcely venture to attack it:—

> "In vaine it were for to declare in verse
> How sumptuously his armour all was wrought;
> All set with stones and gilt with orient gold,
> Both fit for use and pleasant to behold;
> How many arrows under his right side,
> All deadly dangerous, all cruel keene,
> Headed with flint, and feathers bloody dyed,
> Such as the Indians in their quivers hide."

And here we cannot help observing another provision, rendered necessary by the construction of these lance-like spines. The bundles of setæ are all

retractile, and can be drawn into the interior of the body by the aid of the muscular tube from which they spring. It would be superfluous to point out to the reader the danger which would accrue to the animal itself by the presence of such instruments imbedded in its own flesh, it being evident that by every movement of the creature's body they would be inextricably forced into the surrounding tissues. The contrivance to obviate such an accident is as beautiful as it is simple. Every barbed spine is furnished with a smooth, horny sheath, composed of two blades, between which it is lodged; and these, closing upon the barbs when they are drawn inwards, effectually protect the neighbouring soft parts from laceration.

Two cartilaginous-looking flexible antennæ, about half an inch in length, issue from the head, and a row of peduncles, furnished with stiff setæ, borders each side of the body, serving to aid the progress of the animal: nevertheless, when in confinement, its sluggishness is excessive; it scarcely ever stirs, but always seems in a languid state, remaining nearly in the same position, with the posterior extremity of the body recurved, and discharging a constant stream of water from an orifice near the hinder part of its back with so much force, that a slight vortex is formed in the surrounding water.

The movements of these Annelides, when they choose to exert themselves, are, however, very swift, half-running, half-swimming; but they likewise swim with great facility, passing rapidly through the water.

The Aphrodite most probably preys upon living animals, nor does it spare even its own species. Of

two specimens procured at the same time, one was large and fine, two inches and a half in length, the other not quite half as long, but proportionally broader. After living peaceably together during two or three days, the former was found attempting to devour his companion. One half was already swallowed into its strong and capacious proboscis, while the victim struggled desperately to be free. However, the assailant, after retaining the prey for some time, was reluctantly compelled to disgorge it; but the suffering animal's back was broken, and some of the scales ruffled off by the rude assault. Next morning only half of the poor fellow remained, the other portion having been devoured; and the victor now darted out its proboscis repeatedly, in order to finish its meal on the rest, as it lay in a corner.

The *Aphroditaceæ* constitute a group of Annelides to which the term "dorsibranchiate" does not strictly apply, seeing that in the majority of the species belonging to this family no branchial appendages exist either on the back or anywhere else. Respiration is performed on a novel principle, of which no illustration occurs in any other family of worms. The whole back is vaulted over with a series of broad scales, or membranous plates, which exhibit periodical movements of elevation and depression. Overspread by a coating of felt, readily permeable to water, the space beneath these scales during their elevation becomes filled with a large volume of *filtered* water, which during the descent of the scales is forcibly ejected at the posterior end of the body; thus, like a pair of water-bellows, supplying a constant flow of the

respired element over the dorsal surface of the creature's body.

Like the rest of the erratic Annelidans, the favourite retreat of the Aphrodite is under stones or shells, where it adheres, in a reversed position. It is extremely timid, roaming abroad at night, apparently in search of prey; but it always quits its retreat cautiously, as if dreading the vicinity of a foe.

In the middle of June a large specimen of *Aphrodite cirrosa* produced an immense number of eggs, probably not fewer than 10,000, or perhaps more. This great profusion, accumulated on the bottom of a glass vessel, was of a reddish hue, each individual ovum being minute, white, and globular to the naked eye; but as they all proved abortive, we are unacquainted with the form of the embryo, or the history of the progeny to which they give birth.

CHAPTER XXXV.

ARENICOLA PISCATORUM—"THE LUG."

"Amid the bowels of the earth,
Where dawning day does never peep,
His dwelling is."

EVERY visitor to the sea-coast must have remarked certain places on the shore, near low-water mark, almost entirely covered with little pyramids or mounds formed by coils of sand or mud, the "*castings*," as they are called, of worms. All these little heaps are produced by an animal lurking at a considerable depth beneath the surface, named in scientific language *Arenicola piscatorum*, and known by fishermen, who find in it a valuable bait, as the *Lug-worm* or the *Lug* (Pl. VI. fig. 6). There can never be any difficulty in procuring specimens of these worms, if only care be taken to dig deep enough, the spade being driven to the depth of at least a foot and a half into the sand, otherwise the animal will certainly be broken.

When dug up entire, this beautiful Annelidan is found to be about ten inches in length, and in some parts nearly half an inch in thickness, its body being cylindrical, and made up of very numerous segments towards the posterior part. However, it becomes

suddenly reduced in size, and assumes quite a different appearance, as if more uniform in structure, and presenting a shagreen surface. A double row of bunches of setæ project from the sides of the animal, and thirteen pairs of beautiful vermilion-coloured tufts rise from the back, commencing at about one-third of the length from the anterior extremity; these last-named organs, which constitute the respiratory apparatus, are extremely elegant, and when examined with a simple magnifying-glass resemble arborescent shrubs, the stems, boughs and branches of which are all in lively action.

The diversity of colour in this species is very great: of a number collected together, some will be found of a carmine hue, or of a still deeper red, some brownish, and others blackish green, or all these shades are sometimes blended together in the same individual.

Dwelling constantly in the dark, not only deep in the sand, but generally covered by the sea, the Arenicola is extremely impatient of light, and when in confinement continually attempts to penetrate downwards, even when there is no sand in the vessel; but if amply provided with this material, it soon screens itself from view.

The *Arenicola piscatorum* connects the naked with the sedentary Annelida. A viscid secretion exudes from the anterior half of the animal, to which the sand adheres, and hence, when the worm is dug up, this part is generally found to be covered with an imperfect arenaceous tube, within which the movements of the worm are performed with perfect freedom, but which cannot be removed entire, on accou

of its extreme fragility. This tube is, in fact, left behind as the animal progresses, and forms a complete lining for the hole, which, like the brickwork of a well, it supports, and keeps pervious throughout its whole length. The creature is thus enabled to ascend readily to the surface, and the water is admitted freely to the branchiæ.

A few of the anterior rings of the Arenicola progressively diminish in size, and each admits of being completely folded within the ring immediately behind it. Hence, when they are fully retracted, the anterior extremity of the animal appears abruptly truncated; while it is prolonged in the shape of a regular cone when they are projected to an extent just short of developing the mouth. This constitutes its boring apparatus. The rings being retracted, the flat head of the Arenicola is directed against the sand, and then the forcible projection of the cone opens a passage for the rest of the body. The opening thus made would, however, be insufficient, and the delicate branchiæ might be injured while forced through such a narrow passage; but, to avoid this, the animal immediately on completing the penetration distends the penetrating rings very considerably. By the advance of the body the opening thus enlarged is then occupied, and the rings being again received into each other, the cone is ready to be again projected. During the progress of the animal, the glutinous secretion which exudes from it cements together the surrounding sand, and gives that support to the sides of the hole, without which it would immediately fall in.

It is not, however, simply for the purpose of exca-

vating a retreat that the Arenicola thus pioneers beneath the soil—the sand amongst which it works is devoured and swallowed as the worm bores its way: not that the sand itself is nutritive, or can be used as food, but the organic matters mixed up with it—the last scrapings, as we might say, of the platter,—are thus made useful, and become assimilated as the earthy medium traverses the alimentary canal, and it is finally rejected in the form of the sand-coils which betray the retreats of the "lugs" on every sea-beach.

The Arenicola seems to be a favourite article of food to all sorts of marine animals of carnivorous appetite: not the apple of Discord itself stirred up such sanguinary battles, nor was the body of Patroclus more stoutly fought for by the rival Greeks and Trojans than one of these worms, when offered as the prize of fight among the multifarious combatants ready to claim their portion.

In order to study the mutual hostilities of these warlike races, M. Quatrefages threw a large specimen into a pool a few feet wide. A troop of shrimps at first, scared by the sound, darted away; but these soon rallied, just as the Annelide was about to bury itself in the sand, when one, more daring than the rest, grappled it by its middle. Thus emboldened, others lost no time in prosecuting the attack, and the poor worm was pulled about in all directions, till a full-grown prawn, rushing from behind a tuft of coralline, dispersed his feebler comrades, and appropriated the booty to himself." It was, however, at once seen that he would speedily be forced to share the spoil, for at that very instant there appeared some score of Turbos

and small Whelks, who, conscious that a dinner was at hand, all hastened up, evidently for the purpose of participating in the feast. Without any sign of uncertainty or hesitation they moved straight forward toward the anticipated meal, and the worm was soon covered with these predatory mollusks. The fate of the contested prey seemed definitively settled, when a small Shore Crab (*Carcinus Mænas*), issuing from underneath a stone, soon put to flight the shrimps, and, by dragging off the Arenicola, very nearly upset all the Turbos, who forthwith retreated gladly to their sandy haunts. Then, however, a large edible Crab (*Cancer Pagurus*) appeared upon the scene, and the poor little *Mænas* was obliged in his turn to beat a retreat, in order to escape out of the reach of the formidable pincers of his stronger kinsman. Still he kept a watchful eye over the dainty morsel which he had once tasted, and taking advantage of a moment when the larger crab was withdrawing from the field from some temporary emotion of alarm, he rapidly seized the long-disputed Arenicola and carried it for safety to some distance from the water's edge, where he might devour it at his ease upon dry ground, and thus put an end to the combat.

CHAPTER XXXVI.

CRUSTACEA.

We should certainly hesitate before advising a friend possessed of a vivarium well stored with the more delicate offspring of the sea, to introduce Crabs and Lobsters among its inmates, the former more especially; indeed we should almost as soon think of permitting the grunting tenantry of our pig-sty to disport themselves upon a bed of tulips; nevertheless, in a capacious tank, associated with well-selected companions, small specimens of these somewhat unceremonious shell-fish, as they are generally called, will be found by no means devoid of interest, and, from many remarkable circumstances connected with their history, will abundantly repay the little care that is requiste for their preservation.

The Crustacea generally are carnivorous, testifying the same disposition which characterizes other carnivorous animals. They are fierce, cruel and rapacious, devouring alive whatever creatures they can overpower, and not even sparing their own species. The voracity of many is excessive; indeed they only cease to feed from repletion. Their choice is almost indifferent, provided animal matter can be obtained. This, although half, or entirely putrid, is not rejected,

even some marine vegetables are consumed in periods of famine, by these insatiable gormandizers. They are, moreover, very patient of abstinence, that is, when no food is to be obtained, insomuch that we have occasionally received living specimens of land crabs from the West Indies which not only survived the passage, but lived for some time after their arrival, without the slightest nutriment.

The habits of the Crab tribes, as might be well supposed, are exceedingly variable: some, essentially swimmers, are only met with in the open sea; others live near the shore, but never come out of their native element; others again seem to like the air upon the beach almost as much as the water, and may be frequently found hiding themselves under stones; lastly, there are some species which make for themselves a subterranean retreat by digging, or rather scratching, themselves into the sand, where they remain secure from observation.

Neither are they all inhabitants of the sea-shore, at least in the mature stages of their existence. The land-crabs of the West Indies take up their abode amid mountain fastnesses in the interior of the country, living in burrows like rabbits, and only visiting the coast at certain seasons, when, as we shall soon perceive, owing to the exigencies of their newly-hatched progeny, it is essential that their eggs should be consigned to the sea. We have said above, that they are all carnivorous in their appetites, yet even this would seem, in one or two instances to admit of exception.

Mr. Darwin gives an interesting account of a crab,

very common in all parts of the Polynesian islands, which lives on cocoa-nuts, and which grows to a monstrous size. This vegetarian crab has its fore pair of legs terminated by very strong and heavy pincers, and the last pair by others of like structure, which are comparatively narrow and weak. "It would at first be thought quite impossible for a crab to open a strong cocoa-nut, covered with the husk, but Mr. Liesk assures me he has repeatedly seen the operation effected. The crab begins by tearing the husk fibre by fibre, and always at that end under which the three eye-holes are situated; when this is accomplished, the animal commences hammering with its heavy claws on one of these holes till an opening is made; then, turning round its body, by the aid of its posterior and narrow pair of pincers, it extracts the white albumenous substance of the nut. I think this as curious a case of instinct as ever was heard of, and likewise of adaptation of structure between two objects apparently so remote from each other in the scheme of nature as a crab and a cocoa-nut-tree. This crab is diurnal in its habits, but every night it is said to pay a visit to the sea, no doubt for the purpose of moistening its branchiæ. The young are likewise hatched and live for some time on the coast. These crabs inhabit deep burrows, which they excavate beneath the roots of trees; and here they accumulate surprising quantities of the picked fibres of the cocoa-nut husk, on which they rest as on a bed. The Malays sometimes take advantage of their labour by collecting the coarse fibrous substance and using it as junk."

We have nothing to do, however, with cases so exceptional as the above: the occupants of our own coasts are very similar to each other, both in their structure and general œconomy; and as the species are few, the aquariist is not likely to be much embarrassed in his selection.

CHAPTER XXXVII.

CARCINUS MÆNAS—"THE SHORE CRAB."

"There is no danger to profound these mysteries—no *sanctum sanctorum* in philosophy; the world was made to be inhabited by beasts, but studied and contemplated by man: 'tis the debt of our reason we owe unto God, and the homage we pay for not being beasts: without this the world is still as though it had not been, or as it was before the sixth day, when as yet there was not a creature that could conceive or say there was a world. The wisdom of God receives small honour from those vulgar heads that rudely stare about, and with a gross rusticity admire his works: those highly magnify him, whose judicious enquiry into his acts, and deliberate research into his creatures, return the duty of a devout and learned observation."

A SMALL green Crab, running actively over the rocks and sands during the recess of the tide, cannot have escaped the notice of visitors to the sea-beach; and as it is one, from its size and abundance, equally convenient for experiment and observation, we shall review its history at some length.

The Shore Crab (Pl. VII. fig. 4), like all its congeners, is provided with ten limbs, viz. two claws and eight locomotive legs. In all the tribe the claws differ from the legs, being much larger and stronger. They have several important parts to perform: first in holding the food, tearing it asunder, and carrying it to the mouth;

they are likewise the organs of defence and the instruments of offence. The other limbs, disposed in pairs, are adapted for running, and resemble each other, only those of the hind pair are fringed and slightly flattened. The claws, however, are the main and most important weapons, armed with forceps, whose office may be compared to the hands of mankind, and the paws of other animals; they possess remarkable strength in proportion to their dimensions. The motions of the little crab under consideration are lively, quick, and active, but it does not swim: none of our native species is so thoroughly littoral in its habits,—the shore is almost as much the place of its abode as the sea. Wherever rock and weeds and sand abound it is commonly present, ever seeking shelter in the fissures, or under the shelves, so that its body may be protected by some covering.

The *Carcinus Mænas* feeds voraciously; the most convenient food for it is the common mussel, which may be kept fresh a long time—though that seems no great recommendation, seeing that this creature is not nice in the quality of its sustenance: it is one of Nature's scavengers, and feeds as promiscuously as any of them, whether the substance be fresh or putrid —fish or flesh—living or dead. Should a mussel or other bivalve be opened, and the half given to one of these little captives, it is not a little amusing to see how gravely it holds the valve in one claw, and with the other picks out the contents, conveying each morsel to its mouth, just as people employ their hands, until the shell is emptied as cleanly as if cleansed artificially.

There is indeed something irresistibly comical in the imperturbable demeanour of these hard-visaged marauders—nothing can make them laugh—no amount of mischief done, or agony inflicted, for a moment alters the grim, stolid countenance with which they sit,

> "Chattering their iron teeth, and staring wide
> With stony eyes,"

amid the havoc they have caused. A monkey in a lady's boudoir, or a bull in a china-shop, could scarcely prove less eligible inmates than these scrambling tyrants of the well-stored tank. Let the aquariist, therefore, keep them carefully aloof from any specimens of damageable nature. Nevertheless, the study of their habits is by no means devoid of interest; and, under proper treatment, even these creatures have been looked upon as pets, and regarded as "little dumb companions, having always something to impart."

One of the most remarkable phenomena connected with the history of these Crustaceans is the periodical exuviation or change of shell to which they are subject,—a change, the necessity for which must be obvious when we consider the dense, unyielding nature of the stony armour in which their bodies are encased. That they must get rid of their old suit of mail when it becomes too small for their increasing size is evident enough; but how this is to be accomplished is a problem, the solution of which presents so many difficulties, apparently insurmountable by any natural process, that nothing short of actual observation would warrant a belief in its being able to achieve a feat

which might well be considered impossible. To say that the creature casts its skin, as a life-guardsman would lay aside his cuirass and draw off his jack-boots, is easy enough; but how this is to be done with such a cuirass, such legs, and such boots, is by no means of facile explanation. And yet, even under these difficulties,

> "Eternal Providence, exceeding thought,
> Where none appears, can make herself a way."

The mode adopted by Nature appears to be as follows:—

At certain seasons of the year all the limbs are full of flesh; but when the time approaches for changing the shell, the muscles, contrary to the opinion of the ancients*, become flabby, watery, and, in the eatable crab, unfit for food. A soft integument is formed,

* "Cum vires norant se disrumpentes amictus,
Affectant epulas et pascua læta requirunt.
Ut saturo faciles disrumpant corpore crustas
Labitur e toto cum ruptum corpore tegmen,
Hi primum in fulva nunquam lætantur arena,
Nec pastum capiunt, nec quicquam mente revolvunt,
Expectant mortem, vitales ore calores
Non spirant, tenui formidant omnia pelle;
Sunt timidi donec firmentur tegmina membris.
Ac veluti medicus languentem corpore curat,
Atque velut primis epulas gustare diebus
Attenuans calidas morboso in corpore vires
Paulatim præbens epulas, quæ languida membra
Instaurant, donec tanto sint membra dolore
Purgata et vires restent in corpore firmæ;
Sic crustis nuper natis sua membra Paguri
Curant, lethiferum cupientes pellere fatum."

Oppian a Lippio vers.

intervening between the old shell and the body of the animal, and then the subsisting shell opening horizontally between the hind pairs of legs allows the confined crab to escape, clothed in its new integuments.

To follow the course of this remarkable process is extremely interesting, and will be witnessed, at least on the first time of its occurrence, with great surprise.

"I had preserved," says Sir J. Dalyell, "a middle-sized specimen of the *Cancer* (*Carcinus*) *Mœnas* for several months, which had become very tame and familiar. The heat of a sultry summer's day induced me to put it outside the window of my study in a capacious vessel of sea-water, where it remained during the night. Next morning, when thinking little of the matter, a crab, lying on its back in the tank, struck my view, and beside it stood one of larger dimensions, its very image. I hastily concluded that a stranger had been introduced; but, no—exuviation had taken place during the night. The latter was the animal, clothed in its new garb, and close beside it lay its former self, now an empty shell."

The old shell is always found apparently quite entire—all the accessories and minutest parts in their places—bristles, antennæ, eyes, all exactly resemble the living and emancipated crab. And yet, when we consider the amazing complexity of structure presented by the individual portions of the cast-off skeleton, the joints and levers of the various limbs, the numerous jaws, the stony teeth, the innumerable facets of the compound eyes, and reflect upon the difficulties attending the reconstruction of organs so admirable and so delicate, few natural phenomena

can be regarded as more wonderful than the exuviation of one of these creatures.

Another important point connected with the history of these Crustaceans is the metamorphosis, which recent observations prove them to undergo, preparatory to their assumption of the adult form. Nothing, indeed, can be more dissimilar than the appearance presented by the young crab on first escaping from the egg, and that which, after a few moultings, it subsequently presents; and few subjects of microscopical research are more interesting to the inquiring naturalist than the succession of forms by which this change is progressively effected.

Mr. Couch procured some of the Shore Crab (*Carcinus Mænas*) laden with ripe eggs, just ready for hatching. These were transferred to captivity, placed in separate basins, and supplied with sea-water. In about six hours large numbers of strange-looking animals were seen swimming about with all the activity of young life. There could be little doubt that these creatures were the young of the captive inmates. In order, however, to secure accuracy of result, one of the crabs was removed to another vessel, and supplied with filtered water, that all intruders might be removed; but in about half an hour the same creatures were observed swimming about as before. To render the matter still more certain, some of the ova were opened, and the embryo extracted; but shortly afterwards Mr. Couch had the pleasure of witnessing beneath the microscope the natural bursting and escape of one precisely similar in form to those found so abundantly in the water.

Thus, then, there is no doubt that these grotesque-looking novelties are the young of the *Carcinus Mœnas*; but how different they are from the adult need hardly be pointed out any further than by referring to the figure (Pl. VII. fig. 4, *a*). When they first escape, they rarely exceed half a line in length; and yet these minute creatures, in this early state of their existence, are natatory and wonderfully vivacious. They are continually swimming from one part of the vessel to another; and when observed free in their native pools, are, if possible, even more active than when in confinement. Their swimming is produced by continued flexions and extensions of the tail, and by repeated beating motions of their claws; this, together with their grotesque-looking shape, gives them a most extraordinary appearance when under examination. As the shell becomes more solid, they get less active, and retire to the sand at the bottom of the vessel to cast their shells and acquire a new form. They are exceedingly delicate, and require great care and attention to convey them through the first stage; for, unless the water be supplied very frequently, and in great abundance, they soon die.

The second phasis of transmutation (Pl. VII. fig. 4, *b*) is equally remarkable with the first, and quite as distinct from the adult animal. In the species now under consideration, this second transformation is marked by the disappearance of the dorsal spine. The shield becomes flatter and more depressed. The eyes, from being sessile, are now elevated upon footstalks. The claws undergo an entire revolution; the first pair becomes stouter than the others, and armed with

a pair of strong nippers; the tail is greatly diminished in its relative size and proportions, and is sometimes partially bent under the body, but more commonly it is extended. This form is as natatory as the first, and the animals in the state described are frequently found congregating around floating sea-weed, the buoys and strings of the crab-pot marks, and other floating substances both near the shore and in deep water.

The final change confers upon the animal the general form of the perfect crab (Pl. VII. fig. 4), and its natatory habits, in conformity with the changed condition of its limbs, are entirely laid aside.

CHAPTER XXXVIII.

CANCER PAGURUS—"THE EDIBLE CRAB."

"On the other side in one consort there sate
Cruell Revenge, and rancorous Despight,
Disloyal Treason, and hart-burning Hate;
While gnawing Jealousy, out of their sight
Sitting alone, his bitter lips did bight;
And trembling Feare still to and fro did fly,
And found no place where safe he shroud him might."

Most of our readers have, doubtless, seen some of the numerous "happy families" exhibited in the streets of London, consisting of most incongruous assortments of the animal creation, all huddled together in the same gigantic cage, and all looking as miserable and woe-begone as happy families could easily do under any circumstances, and yet we suspect the lot of these poor prisoners to be comparatively enviable when compared with that of the occupants of a tank into which we recently introduced half a dozen specimens of the common Crab whose name is at the head of this chapter. Spenser, when he penned the lines we have adopted as the appropriate introduction to a brief history of their proceedings, might almost be supposed to have been describing them from the life,

and with inimitable accuracy sketched off the striking picture they presented. We had indeed ourselves no idea, when we consigned them to the same vessel, what a set of remorseless villains we had to deal with, and much question whether our reformatory prisons could show such an example of appropriate classification. They were of different sizes, their dimensions progressively increasing in a regular ratio, the biggest being about as large as an ordinary saucer, and seemed each of them at once to be aware of the tender mercies he might expect from his companions, although such a presentiment, if it existed, apparently interfered not a bit with his premeditated designs upon the rest. The game was not long in beginning: the first that ventured out was seized upon at once by the next in size, who, laying hold of his victim as though he had been a biscuit, with one pair of pincers, proceeded deliberately to break up his shell with the other, helping himself to the flesh by means of his finger and thumb with as much deliberation and gusto as if he had been taking snuff from a snuff-box, and apparently caring little for the hungry eyes that seemed to glare with savage delight upon the atrocious spectacle. The Crab had, however, not very long enjoyed his cannibal feast before his proceedings were, as we thought, very unceremoniously interrupted by the onslaught of a stronger foe, which, seizing him exactly as he had done the first, proceeded to break him up in a similar manner, helping himself with the utmost *sang froid* to the flesh of his already well-fed victim; while the latter, strange to say, by no means desisted from his meal upon the crab first slaughtered until

quite disabled by his ruthless assailant,—affording a remarkable illustration of the absence of suffering during the infliction of the well-deserved penalty.

On the morning following this tragical exhibition we were not at all surprised to find, that out of the six captures of the preceding day, only the two largest, which in strength and size were pretty nearly matched, remained alive in the tank, at the two opposite ends of which they sat, each scowling at the other with such looks of undissembled malice, that it seemed an act of pity to disturb their truculent meditations; and, truth to say, all pity for such demons in crustacean guise appeared a maudlin piece of sentimentality quite inappropriate and thrown away; we therefore let them fight it out as best they could; and certainly no trumpet-sound was wanted to incite the doughty combatants to a battle, as fierce as ever was chronicled in the pages of romance:—

> "As when two rams, stirr'd with ambitious pride,
> Fight for the rule of the rich-fleeced flock,
> Their horned fronts, so fierce on either side,
> Do meet, that, with the terror of the shock
> Astonied, both stand senseless as a block,
> Forgetful of the hanging victory,
> Both staring fierce."

Their powers, however, seemed pretty equal, and it was only upon a subsequent occasion that one of them was found immolated and devoured by his inveterate antagonist, whose appetite, like that of the Dragon of Wantley*, was by no means particular.

* "The Dragon of Wantley churches ate—
(He used to come on a Sunday)—

It must not be supposed, however, that the contests between these vicious animals are in any way conducted after the courtly principles of chivalry, or that an honest tilting-match is the extent of their passages of arms; they are not always content with butting against each other, as described in the preceding quotation; on the contrary, nothing can exceed the savage, blind ferocity with which they sometimes ply the work of battle, as if hatred, and revenge, and fiend-like cruelty prompted their fierce encounter; this the mangled claws and limbs wrenched off soon testify, so that the spectator naturally beholds them with a shudder, and of course supposes creatures thus crippled, maimed at least for life. Not a bit of it: the loss of a few legs to these wretches appears to be a very trifling accident, and, strange to say, is very speedily repaired:—

"Him they dismember'd often, and not slew;
Nor he, because dismember'd, ever dies,
For he remodels leg or hand like wax*;"—

and in a short time presents himself with a new set of limbs, quite as complete and efficient as their predecessors.

Whole congregations were to him
A dish of Salmagundi;
The corporation worshipful
He valued not an ace,
But swallow'd the mayor, asleep in his chair,
And pick'd his teeth with the mace."

"Piu volte l' hanno smembrato e non mai uccidea,
Ne per smembrarlo uccider si potea,
Chè se tagliato o mano o gamba gli era,
La rappiccava che parea di cera."

Scarcely more wonderful is the scene recounted in 'Orlando Furioso,' relative to the fight between Orillo, the necromancer, and the English duke, than the phenomenon which nature in this case presents us with in real sober earnest, although perhaps some of our readers may have imagined that in writing the lines alluded to, Ariosto had transgressed the licence even of romance:—

"About the field Orillo's members flew,
But he together gathers them againe,
And straight his fight and forces doth renew;
The English Duke dismembering him in vaine;
Until at length one blow so luckie sped,
That by his shoulders he cut off his head."

"And having headed him so even and so just,
Straight with his head on horseback he doth mount,
And rides away. Orillo in the dust
Doth grope to find the same, as he was wont;
But missing it, and full of new mistrust,
To overtake him yet he makes account;
He rides, and would have cried, Ho! tarrie! tarrie!
But in his hand the Duke his tongue did carrie."

Combat between Astolfo and Orillo—Orlando Furioso.

And now once more to revert to the stern facts of natural history, as recorded by Sir John Dalyell.

Individuals of the common Crab, when kept alone, become very tame; whence, says Sir John, for a long time I was induced to think them of an extremely pacific nature; but four small ones having been committed to the same vessel, I was soon undeceived by discovering that one had been devoured by a companion. On the same day I found the smallest of

the survivors in the fangs of the largest, nor could I rescue it without the loss of several of its limbs.

This unfortunate creature being shifted into another vessel, immediately began to feed on some portions of mussel with as much gusto as if nothing had happened; nevertheless it proved to have undergone extraordinary mutilation; seven of its ten legs were actually gone, for only the two claws and the posterior right limb remained; these, however, were entire, and the next day the animal seemed quite hearty. Ninety-four days after this mutilation the victim cast its shell, when, wonderful to relate! the whole complement of ten limbs was found again complete; those corresponding to the seven which had been deficient being somewhat under the natural size, but in all other respects as perfect and efficient as their predecessors.

The Edible Crab inhabits the whole of our coasts, preferring those parts which are rocky, and its usual retreats are amongst the holes in the rocks, whither it generally retires, and is often to be taken in such situations when the tide has retreated sufficiently to render the localities accessible. Specimens so found are, however, always small individuals, rarely more than three inches in breadth; the larger ones remain farther out at sea, in deep water; they also bury themselves in the sand, but always in the immediate neighbourhood of their lurking-places.

The food of this species, like that of most other Crustacea, consists principally of animal matter, such as dead fish and the like; and it is exceedingly probable that the Crabs discover their prey rather by a

sense analogous to that of smell than by sight. Thus they detect a bait which is often placed in such situations that it cannot be seen by them at any distance, and which generally consists of pieces of fish in which decomposition has already commenced.

The fishery for these Crabs constitutes an important trade on many parts of the coast. The numbers which are taken are immense; and as the occupation of procuring them is principally carried on by persons who are past the more laborious and dangerous pursuit of general fishing, it affords a means of subsistence to many a poor man, who, from age or infirmity, would be unable without it to keep himself and his family from the workhouse. They are taken in what are termed "Crab-pots," a sort of wicker trap, made by preference of the twigs of the Golden Willow (*Salix vitellina*), on account of its great durability and toughness. These "pots" are constructed on the principle of a common wire mouse-trap, but with the entrance at the top. They are baited with pieces of fish, generally of some otherwise useless kind, and these are fixed into the pots by means of a skewer. The pots are then sunk by stones attached to the bottom, and the situation where they are dropped is indicated, and the means of raising them provided for, by a long line, having a piece of cork attached to the free end, which, floating on the sea, indicates the position of the trap.

CHAPTER XXXIX.

PAGURUS BERNHARDUS—"HERMIT CRAB."

"But in the porch doth evermore abide
An hideous giant, awful to behold,
That stops the entrance with his spacious stride,
And with the terror of his countenance bold
Full many doth affray."

It is curious to observe the strange alliances by which animals of most opposite habits, and evidently remote from each other in zoological resemblance, are sometimes associated, the necessities of the one being provided for in an extraordinary manner by some peculiarity in the structure or general œconomy of the other, without which the existence of a creature so constituted would be impossible.

The Pagurus Bernhardus, or Hermit Crab (Pl. VII. fig. 1), is a crustacean whose appearance must be familiar to every one frequenting the sea-shore. If it is not, the reader has only to take advantage of a low tide upon some shelving beach in order to gratify his curiosity. In such situations he will doubtless be puzzled at beholding a number of turbinated shells traversing the sands in all directions, as if of their own accord, but after a fashion evidently widely different from what would be followed by the proper

owners of the tenements. Some of these shells are of small dimensions, others much larger, all seeming to be wandering about after their individual pursuits, though not apparently guided by any common impulse. If the progress of these peripatetic shells be interrupted, they at once stand still, and then each of them is found upon examination to be the residence of a *Hermit Crab.*

To comprehend the shape of this animal, it is necessary to deprive it of its habitation. It is then seen to be formed of two distinct portions,—the head and a good portion of the body being covered with shell, like the fore part of a lobster; whilst the hinder, or tail portion, is bare, soft, and devoid of any solid protection; so that, in order to defend its nether regions, the creature is obliged to have recourse to the strange expedient of making an extempore sentry-box of any shells that, from their size and shape, may be adapted to such a purpose, and which the occupants are compelled to drag about with them on all occasions.

It is still a question undecided whether the Hermit Crab always selects for its habitation a shell already empty, or whether it does not sometimes actually kill and devour the original inhabitant before taking possession of its outraged abode, and thus add murder to piracy.

The fishermen on the coast state its proceedings for securing the ejection of the lawful tenant to be summary enough: the aggressor seizes his victim—the whelk for instance—immediately behind the head, and, after thus killing or disabling it, at once proceeds to eat it out of house and home, and then to

appropriate its vacant residence, affording thus a striking illustration of

> "The short, the simple plan,
> That they shall take who have the power,
> And they shall keep who can."

When feeding or walking about, the head and thorax of the Hermit Crab project beyond the mouth of the shell; but when they are alarmed, they draw themselves in, closing the aperture of their domicile with one of their claws, which is much larger than the other. They hold on so firmly to their retreat, that they will rather be torn asunder than quit their attachment; nevertheless, as they increase in size, they are obliged to change their habitation for a more commodious one, and the way in which they do this is very amusing. They may, on such occasions, be frequently observed crawling along a line of empty shells left by the last wave; and, as if unwilling to part with their old domicile till a new one has been obtained, they slip their tails out of the old house into the new one, speedily again betaking themselves to the former, if the latter is not found suitable. In this manner they not unfrequently try a great number of shells before they find one to their liking, and combat fiercely for the possession of a promising lodging.

It will readily be supposed that, in order to adapt these shell-frequenting anchorites to occupy a domicile so foreign to the usual habits of their class, corresponding modifications in the structure of the animals will be rendered necessary; accordingly the pecu-

liarities of their form, and the wonderful adaptation of all the limbs to a residence in such a dwelling, cannot fail to strike the most incurious observer. The chelæ or large claws are proportionately strong and massive, armed with blunt tuberculated teeth, and sufficiently formidable in their aspect to render our advice to young ladies not to put their fingers within the reach of such a tenacious pair of pincers, probably superfluous. It will be observed, moreover, that these claws differ remarkably in size, one being exceedingly small as compared with its fellow,—a provision, the wisdom of which becomes at once apparent when the animal retreats into its citadel. Had the two chelæ been of equal dimensions, and both of them as large as the biggest of them, it is evident that they could never have been retracted within the orifice of the shelly residence; whereas, by the plan adopted, when the animal retires into its concealment, the smaller one may be entirely withdrawn, while the larger closes and guards the orifice.

The two succeeding pairs of legs, which alone are used for walking, and are consequently of great size and strength, unlike the corresponding pairs of the Lobster, which are terminated by pincers, end in strong pointed levers, whereby the animal can not only crawl along, but drag after it its heavy habitation; both which operations are effected with such vigour and energy, that we warn our friends, that they might as well set a pair of horses dragging a plough behind them to promenade their choicest parterres, as to allow one of these creatures to roam about in a delicately-stocked aquarium: their path is marked—

"As when the fierce south wind, or bleaker north,
Has burst into the thickest of a wood,
And rushing on, to force a passage forth,
Behind him leaves a prostrate forest strew'd,
And drives before him with a madman's mirth
The foliage flying."

As surely as the evening comes, so surely do these devastators begin their gambols, till, with their pick-axe legs and harrowing shells, they have torn, raked up, and mangled everything within. Truly it may be said, that, where they have their way,

"Ruin itself stands still for lack of work,
And Desolation keeps unbroken sabbath."

Behind the powerful locomotive legs are two feeble pairs, barely strong enough to enable the Hermit Crab to shift his position in his retreat; and the false feet attached to the abdomen are even still more rudimentary in their development. But the most singularly-altered portion of the skeleton is the fin of the tail, which here becomes transformed into a kind of holding-apparatus, by the aid whereof the creature retains a firm grasp upon the interior of the apex of the shell forming his residence, and thus carries it about without any difficulty.

The Hermit Crab is lively and very voracious; it is, however, of a peaceful disposition, so that several specimens may be placed in the same tank, where they will live for a considerable time on terms of apparent friendship; although, truth to say, their amicable conduct is probably rather owing to the impossibility of attacking their neighbours, except upon the same terms as a dog attempts to draw a

badger from the tub, defended by his vice-like jaws and formidable teeth.

For the most part they feed upon dead fish; but they are by no means particular, and eagerly devour whatever garbage may be thrown on the shore by the receding tide, and thus become important agents in the grand police of Nature, assisting most materially to cleanse our coasts.

CHAPTER XL.

PALÆMON SERRATUS—"THE PRAWN."

"Did not goodwife Keetch, the butcher's wife, come in then, and call me gossip Quickly? coming in to borrow a mess of vinegar: telling us, she had a good dish of prawns; whereby thou didst desire to eat some; whereby I told thee, they were ill for a green wound?"—*King Henry IV.* Part 2.

We are free to confess, that although we never had the opportunity of luxuriating upon a dish of prawns in conjunction with "a mess of vinegar," as associated in the preceding quotation, we are by no means without a proper appreciation of the value of these delicate edibles in an epicurean point of view, and acknowledge at once that, whether employed for the *garniture* of a turbot or a salmon, or in any other manner made adjuncts to the ornamentation of the dining-table, they always command our respectful attention; nay, we will even go a step further, and avow, that fresh shrimps are not without their attractions in our eyes, whether as the appropriate accompaniments of a sea-side breakfast, or in their more doubtful character, as belonging to the tea-parties of Greenwich, or of less classic Gravesend. We are not

sure that we will disallow our approval of shrimp-sauce, indeed we fear we have admitted as much on a former occasion; and as to potted-shrimps—ye nymphs of Lancaster! can we be so ungrateful as to forget them? No! the proud forms of

"Gaunt's embattled towers"

may vanish from our memory, but still the shrimps of Morecamb Bay, embalmed by fairy fingers—Hold! we must not dwell on such a theme. We are just now above such gastronomic thoughts.

We will suppose ourselves upon the silent shore at evening's first approach, as the declining sun steals gently towards the horizon, and the receding tide lays bare the wave-worn beach :—

"Back to its bed the ocean creeps,
Clear as a mirror shine the deeps,
One smile on sea and sky;
All softly breaks the rippling tide,
Low murmuring on the rocky land,
And playful wavelets gently glide,
As they approach the strand."

And here, amid this labyrinth of tangled wrack and weed-crowned stones, we wander on in search of pretty things, such as the waves bequeathe us. Let us sit awhile upon this rock, beside the margin of the quiet pool left in the hollow of its ample base :—

"An elfin pool so shelter'd, that its rest
No winds disturb; the mirror of whose breast
Is smooth as clear, save where, with dimples small,
A fly may settle or a blossom fall."

On looking down through its translucent waters, we

perceive it is not uninhabited by fairy forms, scarcely to be detected even by the eye of the keen naturalist, so pure and crystalline their texture is, so glass-like and transparent, now gliding here and there like delicate shadows, and anon darting away

"Swift as an arrow from the bow of Love,"

to be lost within the shelter of their fastnesses.

And are these beauteous-seeming visions Prawns and Shrimps—the things they drown in melted butter and prepare with spice? 'Tis even so; yet, who would think creatures so frail as these were not as evanescent as the icicle?

Now let us watch them more attentively, and scan awhile their exquisite construction, as they rove in numerous companies around their lake, some basking in the sun, disporting as at play amongst the coral-lines and fuci that wave round them, while the rest, retired from observation, seek the shade,

. . . . "or under rocks their food
In jointed armour wait."

It is not, however, in their native haunts that we can study them satisfactorily. Let us transfer a few of them to the tank, and there endeavour, under the guidance of Mr. Warington, to become more intimately acquainted with the history of creatures so remote in form from any we have yet encountered.

Into one of Mr. Warington's aquaria, the contents of which consisted of *Ulva latissima* and *Enteromorpha*, as the vegetable members of the circle; and of several varieties of *Actinia, Madrepora, Annelida*, &c., to represent the animal section; while the functions

of the scavengering mollusks were fulfilled by *Littorina, Trochus,* and *Purpura*; a few individuals of the common Prawn (*Palæmon serratus*) were introduced during the months of October and November. They were fed every second or third day with small pieces of either oyster, mussel, cockle, shrimp, and the like; or, when these could not be obtained, with softened shreds of raw, lean meat, which had been previously dried by exposure to the air, in order to preserve it from putrefaction, and allow of its being kept as a store of provision, capable of being had recourse to as occasion might require.

The manner in which these beautiful creatures take their food, while foraging about the tank, is very interesting. The first and second pairs of forceps-like feet are cautiously and continuously thrust into every cranny, as well as around and partially under the pebbles and rockwork, and often into the tubes of Serpulæ and Sabellæ, or the shells of the univalve mollusks; and these, if not protected by an operculum, or some provision for closing the orifice of their tube or shell, soon fall a prey to their attacks. When anything edible is met with, it is rapidly seized by these prehensile feet and transferred to the jaws.

The senses of touch and smell in the *Palæmonidæ* are exceedingly delicate, the latter appearing to reside most strongly in the antennæ. Thus, when a small particle of food has been dropped into the water and has sunk to the bottom, the moment the antennæ of the prawn in its movements pass across the column of water through which the food has fallen, the whole motion of the creature becomes changed in an

instant, and it darts rapidly here and there from the surface throughout the path of its transit until it is discovered; and often, after it has been devoured, a second prawn will, on reaching the same locality, gain the scent, and hunt over every spot in search of that which has been already removed, but which evidently had left its odour behind. It has very often occurred, that if some one of the Actiniæ had been first fed, the prawn, on gaining the scent, has tracked the food to the Actinia and speedily rifled it of its repast; and in instances where the zoophyte had even transferred its meal by means of its tentacula into its pouch, the prawn has redoubled its efforts, and frequently dragged the savoury morsel out of its very stomach. This operation it effects in a very surprising manner: the *Palæmon* charges, without any apparent fear, full on the extended disc of the Actinia, the tentacula of which it keeps in constant play by means of its three pairs of unarmed feet, while at the same time one of the second, or larger pair of prehensile feet, is thrust into the orifice of its maw, and the food forcibly and quickly extracted. The only chance the poor Actinia has of preventing this, and securing its feast, appears to be by contracting the whole of its tentacula together, so as to close entirely all approach to its stomach. The energy with which this attack is effected depends very much upon the keenness of the prawn's appetite; and in cases where the Actinia is strong, and also very hungry, the conflict is often severe, and the aggression is sometimes, though rarely, successfully repelled.

The first pair of didactylous, or forceps-like feet of

the prawn, are slender and most delicate in their structure, and, when examined with a magnifying-glass, are found to be provided at their extremities with a brush-like appendage of short hairs standing out at right angles to the claw. The power of motion with which these legs are endued is really wonderful, and their usefulness is applied in every conceivable direction—around the eyes, and among the apparently complicated apparatus of mandibles, antennæ and palpi, at the head, within or beneath the carapace, and for some distance between it and the body, particularly when the period for moulting is approaching; they are employed also for the cleansing of the abdominal false-feet or swimming-webs, and the expanded lobes of the tail; and the appearance of the prawn during the execution of this brushing or scrubbing process is grotesque in the extreme: the body is supported and raised high on the four pairs of legs, the abdominal part and tail being curved forward between them, so that the whole posterior division of the animal can be brought within the reach of the first pair of feet, and thus the necessary cleansing operation be readily effected.

When in full swimming action, the appearance of these beautifully transparent crustaceans is most elegant. The front feet are generally laid backward, and tucked under the body, like the fore-legs of the deer-tribe in the act of leaping. The long and delicate antennæ stream gracefully on each side of its body, and float for some distance beyond its entire length; while its strong abdominal paddles propel it rapidly through the water. In the aquarium under

consideration, these delicate playmates were in the habit, on the summer evenings, of careering to and fro close to the glass-front of the case, presenting a most pleasing spectacle, and one which must be observed in order to be appreciated, as no description can convey an adequate idea of the interesting scene.

It is also a curious and striking phenomenon to observe these creatures, by the aid of a lighted candle or lamp, in a dark room, during the night, in consequence of the bright reflection of the luminous body from their prominent pedunculated eyes; for as the prawn does not retain a stationary position, but slowly roams about through the water and over the rock-work, seeking for its food, it adds an increased interest to its appearance to behold these small globes of bright light, like the bull's-eye signal-lamps of a miniature railway-engine looming through the distance in a dark night, moving slowly along, the body of the creature being quite imperceptible, and nothing visible but these pairs of globular balls of fire shining from out the dark water.

When the period arrives at which the prawn is about to throw off its old external covering, it ceases to feed, and seeks about from spot to spot in a restless and fidgety manner until it has fixed upon a locality sufficiently adapted for the purpose required, and suited to its fancy; for this really appears to be sometimes the case. The third, fourth and fifth pairs of legs are then stretched out wide apart, and the feet hooked on so as to hold firmly upon the surrounding substances in such a way that the body may be poised,

and capable of moving freely in all directions, as though suspended on gimbals.

The prawn then slowly sways itself to and fro, and from side to side, with strong muscular efforts, apparently for the purpose of loosening the whole surface of the body from the carapace; the two pairs of prehensile or didactylous legs are at the same time kept raised from the ground—stretched forwards, and frequently passed over each other with a rubbing motion, as if to destroy any remaining adhesion; the eyes also may be observed to be moved within their covering, from side to side, by muscular contraction; and when every precaution appears to have been perfectly taken for the withdrawal of its body from its too limited habiliments, a fissure is observed to take place between the carapace and the abdomen, at the upper and back part, and the head, antennæ, legs, feet, and all their appendages, are slowly and carefully drawn backwards and out from the dorsal shield, until the eyes are quite clear of the body-shell or carapace, and appear above its margin; the prawn, thus half released, then makes a sudden backward spring or jerk, and the whole of the exuvium is left behind, generally adhering by the shell of the six feet to the surface it had selected for its purpose.

A moment's consideration will develope to the contemplative mind, writes Mr. Warington, what a truly wondrous process this act of exuviation really is. When we reflect on the small size of this crustacean, and the extreme delicacy and intricacy of all its various organs, and then find that in this moulting, the shell of the most minute and complicated of these

structures is thrown off in a complete and uninterrupted state, even to the gauze-like membrane covering the projecting and pedicled eye, the filamentous antennæ, the many-jointed legs, the delicate didactylous hand, the paddled abdomen with its beautiful appendages, the palpi, and all the minute spines and microscopic hairs with which these various members are provided—the human mind can hardly appreciate the wonderful wisdom of the Creative Power that could have called into existence so marvellous an adaptation.

At the moment the prawn has been thus liberated from its old envelope, it rolls on the surface of the ground, perfectly helpless; for it is at first evidently so soft, that it does not possess the power of supporting its own weight erect upon its feet, while the beautifully delicate antennæ float from its head like gossamer-threads through the water. In a short time, however, it plunges or springs by a strong muscular exertion of its abdomen from place to place, stretches its webbed tail and the large paddles of its swimming apparatus, and soon retreats into some dark and sheltered corner, where it remains, continually exercising its various organs, until such time as the new investing membrane shall have become sufficiently hardened to allow of its venturing forth among its companions without danger; for during all this interval it is liable to their attacks whenever it comes near them, and is obliged by a series of forcible leaps rapidly to evade their attempts, and to keep out of their way.

When the newly-coated *Palæmon* first makes its

exit from its hiding-place, its appearance is doubly beautiful; the colours are so clear and bright, particularly the orange and rich brown bands which encircle the pale blue prehensile feet, the various markings are so defined, the small spines and fringes of hair so clean and well-developed, and the deportment of the creature is altogether so bold and vain-glorious, as though proud of its new vesture, that it cannot but command the admiration it seems to seek.

From the observations of Mr. Warington, it appears that the period intervening between the exuviations of the prawn varies from twelve to twenty-four days. This variation may depend upon the quantity of food taken by the respective individuals, and also on the varying temperature of the aquarium. If the cast-skins be not removed from the water, the prawns will devour all the smaller and softer parts, as the legs, the palpi, and the false or swimming feet, with great rapidity.

For the benefit of such zoologists as may wish to witness for themselves the hatching of the ova of the *Prawn*, it may be observed, that the females, which are vastly more numerous than the males, carry their ova attached in groups to the inner branch of the subabdominal fins, and that these ova are at first of an oval figure, a pale yellowish-brown colour, and small size; but as they increase in size, they become more round, change to a dark brown, then to a reddish brown, and gradually acquiring greater translucency, at length assume a pale flesh-colour, with black eyes seen through their transparent covering. Females arrived at this last stage of gestation, being

kept in frequently renewed sea-water for a few days, will enable the aquariist to observe the strange form under which the progeny of these crustaceans first make their appearance from the egg, and perhaps, with care and attention, to trace their subsequent metamorphoses, two phases of which we have figured (Pl. VII. fig. 2).

CHAPTER XLI.

PINNOTHERES—TALITRUS—COROPHIUM, ETC.

"Pour'd from the neighbouring strand, deform'd to view,
They march—a sudden, unexpected crew!
Strong suits of armour round their bodies close,
Which, like thick anvils, blunt the force of blows;
In wheeling marches form'd, oblique they go;
With harpy claws their limbs are arm'd below;
Fell shears the passage to their mouth command;
From out their flesh their bones by nature stand;
Broad spread their backs, their shining shoulders rise;
Unnumber'd joints distort their lengthen'd thighs;
With stony gloves their hands are firmly cased;
Their round black eyeballs in their bosom placed;
On eight long feet the wondrous warriors tread,
And either end alike supplies a head.
These, mortal wits to name as CRABS agree,—
The Gods have other names for things than we."

Battle of the Frogs, &c.

HAVING in the last chapters given a somewhat detailed account of the principal facts connected with the history of the larger and more interesting Crustacea ordinarily met with upon our coasts, we shall proceed to notice more discursively a few others of common occurrence, selected from the long catalogue of our native species:—

. . . . . "Terrible things with terrible names;
Names that we all know by sight very well,
But which no one can speak, and no one can spell."

And first we will select the PINNOPHYLAX, or PINNOTHERES VETERUM, as at least affording an illustration of the development of the bump of imaginativeness upon the skulls of natural-historians.

The history of this pretty little creature, the PEA-CRAB of our vernacular nomenclature, has from remote antiquity been a puzzle. It seems always to be found in the society of another animal, and that apparently a most unlikely associate, namely the Horse-mussel (*Mytilus modiolus*), insomuch that the history of one is generally interwoven with that of the other. Mr. W. Thompson observes, that on the coast of Ireland he opened eighteen of these mussels, and in them found no fewer than fourteen of the Pinnotheres, all females; and Mr. J. V. Thompson remarks, that on any bank of old *Modioli* or *Pinnæ*, where these little crabs have been observed, almost every shell will be found to contain at least one grown female, some two, others three, independent of young ones and males occupying them in common with the females. Neither is this peculiarity in their history by any means a modern discovery; from the remotest antiquity it has been a subject of admiration both to poets and philosophers. The friendship of Damon and Pythias has not been half so celebrated as that between "Pinna and her Cancer friend;" neither has any zoologist, from Aristotle to Linnæus, neglected to afford a passing tribute of admiration to the matchless fidelity of these strange lovers, the reality of which is as much

a myth as the affection of Petrarch for Laura, or the loves of Eloisa and Abelard. Let them, however, speak for themselves, and we will give Linnæus the *pas*.

"The Pinna or Sea-wing is contained in a two-valved shell, weighing sometimes fifteen pounds, and emits a beard of fine, long, glossy, silk-like fibres, by which it is suspended to the rocks, twenty or thirty feet beneath the surface of the sea. In this situation it is so successfully attacked by the eight-footed Polypus, that the species perhaps could not exist but for the exertions of the *Cancer Pinnotheres*, who lives in the same shell, as a guard and companion *."

"The Pinnotheres, or Pinnophylax, is a small crab, but is furnished with good eyes, and lives in the same shell with the Pinna. When they want food, the Pinna opens the shell and sends its faithful ally to forage; but if the Cancer sees the Polypus, he returns suddenly to the arms of his blind hostess, who by closing the shell avoids the fury of her enemy; otherwise, when it has procured a booty, it brings it to the opening of the shell, where it is admitted, and they divide the prey. This was observed by Haselquist in his voyage to Palestine †."

Crabs, either of this kind or allied to them, the ancients believed to have been the voluntary inmates of the *Pinnæ* and other bivalve shells, which, being too stupid to perceive the approach of their prey, were warned of it by their vigilant friend. Oppian, who calls the Crab *πιννοφύλαξ*, tells the fable prettily :—

* 'Amœn. Acad.' vol. ii. p. 48.—Linnæus, 'Syst. Naturæ,' vol. i. pp. 1040 and 1159.

† Darwin (Dr.), 'Botanic Garden,' pp. 392, 393.

"In clouded deeps below, the Pinna hides,
And through the silent path obscurely glides;
A stupid wretch, and void of thoughtful care,
He forms no bait, nor lays a tempting snare.
But the dull sluggard boasts a Crab his friend,
Whose busy eyes the coming prey attend.
One room contains them, and the partners dwell
Beneath the convex of one sloping shell;
Deep in the watery waste the comrades rove,
And mutual interest binds their constant love;
That wiser friend the lucky juncture tells,
When in the circuit of his gaping shells,
Fish, wandering, enter; then the bearded guide
Warns the dull mate, and pricks his tender side;
He knows the hint, nor at the treatment grieves,
But hugs the advantage and the pain forgives.
His closing shells the Pinna sudden joins,
And 'twixt the pressing sides his prey confines.
Thus fed by mutual aid, the friendly pair
Divide their gains, and all the plunder share."

OPPIAN, *Halieut.*

Whether the motives which actuate the Pinnotheres are as friendly as above represented, we consider to be rather more than doubtful; but it certainly does not appear that this animal rambles at large like others of its restless fraternity; on the contrary, it is a constant inmate of some bivalve shell, dwelling there in peace along with its owner.

The body of this elegant little crab is nearly circular, and not above half an inch in diameter; its two claws and eight locomotive limbs are rather slender, and well-proportioned. Two red eyes in front are placed considerably apart, and scarcely project beyond the margin of the shell. The colour of

the whole animal is a delicate red, or reddish cream-colour. The creature is very timid, inactive, and extremely susceptible of atmospheric changes. On the slightest shock the limbs contract, and it will lay supine and motionless, as if dead, or counterfeiting death, for an extraordinary length of time. It feeds readily upon mussel, and is easily kept in the aquarium, where specimens have been known to survive fourteen months. Perhaps some of our readers may be enabled to furnish a new episode in its poetical history. Poetical speculations, however, are very dangerous examples to the student; false facts are far more dangerous in science than false theories; neither can it ever be too deeply impressed upon the mind of the aspirant to zoological reputation, that

> . . . . . "those who greedily pursue
> Things wonderful instead of true;
> That in their speculations choose
> To make discoveries strange news;
> And natural history a gazette
> Of tales stupendous and far-fet;
> Hold no truth worthy to be known,
> That is not huge and overgrown,
> And explicate appearances,
> Not as they are, but as *they* please;
> In vain strive Nature to suborn,
> And for their pains are paid with scorn."

It may, however, be just possible that the Pinnotheres is by no means so disinterested in her attentions to her bivalve landlady, and that the molluscous owner of the house would have no objection to get rid of her lodgers; for there are some crabs, as Oppian tells us, that are very fond of oysters; but being quite

wise enough to appreciate the dangers attendant upon helping themselves to the delicious meal, placed between a pair of shells, as though to be the bait of a live trap, in which they might be caught by the claws like rats or mice, are obliged to be cautious: watching, therefore, their opportunity, when the oyster opens its shells to enjoy a little sunshine, the cunning crustacean just pops a stone between the two valves, and then proceeds to pick out leisurely the tempting morsels *. Perhaps the Pea-Crab is partial to mussel, and once within the shell, luxuriates at leisure on her favourite food.

Passing on to the various other forms of Crustaceans everywhere to be met with on our coasts, the naturalist need never want employment, or the admirer of the grotesque and strange, subjects for amusement.

The SEA-SPIDERS, as they are not inappropriately designated, present a remarkable group of singularly constructed creatures, from among which many species, well adapted to the aquarium, may easily be selected, more especially as they are comparatively of harmless disposition. Their movements are slow

* "Si quis in æquorea Cancrum conspexerit alga,
Laudibus extollet, tantam mirabitur artem.
Concessa ex alto solers prudentia Cancro,
Cui parta est dulcis magno sine præda labore.
Ostrea distendit testas et claustra recludit
Portarum, pascitque lutum, scopulisque repanda
Gliscit aquas, parvum madida de rupe lapillum
Obliquus tollit Cancer, chelisque recurvis
Continet, in testis lapidem demittit apertis,
Assidet, atque epulis lætus saturatur amicis."

and unstable; the weakness of their claws renders them but little formidable to other occupants of the tank, and they live only upon the softest and most helpless kind of prey. The *Maia squinado*, the species which, together with its progeny, we have selected as an example of their general form (Pl. VII. fig. 3), was of great reputation among the ancients, and is figured on some of their medals. They attributed to it the possession of a great deal of wisdom, and believed it to be sensible of the charms of music, with how much justice we will not pretend to say; we never saw it dance even to the all-inspiriting tune of Sir Roger de Coverley; perhaps its habits are too demure to permit of such hilarious levity.

The Sea-Spiders live, for the most part, at considerable depths in the sea, where they hide themselves amongst the sea-weed. They are likewise frequently to be met with on oyster-beds.

Aristophanes makes a crab say to a serpent which he had seized in his claws, "Why don't you walk straight forward, sir, as I do?"—a piece of fun, only to be appreciated by those who have had an opportunity of witnessing the singular obliquity with which some of these creatures crawl on their long stilt-like legs about the rockwork of their prison,—

> "Like a tom-cat in a thievish vein,
> That round the walls doth slily creep,"

preserving all the while a gravity of demeanour so imperturbable, that it is difficult to watch them without laughing at the oddity of their proceedings.

We mention the Isopod and Amphipod Crusta-

ceans rather for the purpose of warning the aquariist against their destructive ravages than of recommending them as objects fit for admission into his tanks, except for the purpose of specially investigating their own habits, some of which are sufficiently remarkable.

Of these, myriads may be met with on turning over any heap of sea-weed left upon the beach by the receding tide—jumping about in all directions like so many grasshoppers, and that with such activity, that, out of hundreds which may be skipping about, the collector will be lucky in catching two or three individuals; in fact, the capture of these creatures is one of those exceptional pieces of business that can only be done well when done in a hurry. The mode in which these animals leap is curious. To execute their active movements, they bend under the body certain appendages belonging to their tails, and then, suddenly letting them go like a spring, they are thrown into the air by the jerk, just upon the principle of the "skip-jacks" with which children amuse themselves. When placed in the water, they swim about by means of the contractions of their tail, aided by the movements of their feet; and some, in consequence of the extreme compression of their body, and the very strong curvature of the tail, are obliged, when at rest, to remain continually couched on one side.

The Sand-hoppers live on animals smaller than themselves, or on dead bodies cast on shore by the waves; they are themselves eagerly devoured by aquatic birds, and form an excellent bait for taking small fishes by the line. They carry their eggs under

the scales of the breast, and in this situation the young ones remain until strong enough to provide for themselves.

The existence of a sense corresponding to that of smell among the Sand-hoppers (although where such a sense resides it is difficult to give any satisfactory opinion) may be inferred from the fact, that if, in any locality frequented by these creatures, a dead fish, or any other dead animal, be buried under a heap of stones, it is sure to be found in the course of a few days devoured by hosts of these indefatigable scavengers, whose knowledge of the whereabouts of such a booty could only be derived from the effluvia of putrefaction emanating therefrom.

Among these littoral crustaceans, a very curious species, named the LONG-HORNED COROPHIUM, lives in holes which it forms in the mud; and against this we specially warn our readers. It carries on a perpetual warfare against the Nereids, the Amphinomes, the Arenicolæ, and other marine Annelidans which make their dwelling in the same localities. There is nothing more curious than to see, at the rising of the tide, myriads of these crustacea bestirring themselves in all directions, striking the mud with their long arms, and thinning it for the purpose of discovering their prey. When they find an unfortunate Annelide, often ten or twenty times larger than themselves, they unite in companies for the purpose of attacking and devouring it; nor do they give over their carnage until they have smoothed and thoroughly searched the mud and slime, and left it bare of all its gay inhabitants. The mussel-fishers even pretend that they

cut the threads whereby those shell-fish suspend themselves, so as to make them fall into the mud; and that they then devour them.

Not the least remarkable circumstance connected with the history of the Amphipods, is that some of them construct tubes, somewhat after the manner of the caddis-worms among insects.

"Some years since," observes Mr. Spence Bate, "I had in a glass-case a few Amphipod Crustaceans in sea-water, with a little weed. After a short time, an hour or two, I was surprised to find that one of these small creatures had managed to bend a portion of a leaf of green Ulva upon itself, and cement the same into a tube-like case, in which it lived, putting out its head and antennæ only;—upon being disturbed at one extremity, it would quickly turn within its abode, and protrude its head at the other. I thought it curious at the time, but pursued the subject no farther, until more recent and longer-extended opportunities showed that the above was by no means an isolated instance, but that a large and well-marked group of these animals enjoy this power of constructing for themselves temporary residences; while another, equally distinguishable, dwell in abodes that they have made by excavating channels in clay, mud, or even wood."

When engaged in prosecuting these observations, Mr. Bate kept in a small tank several specimens of *Amphitoë rubricata* dredged up at the east end of Plymouth Breakwater. "These varied in their ages, from the very young to the well-advanced adult, all of which, in the course of a short time, fabricated for

themselves nests formed partly of foreign materials, and partly of a kind of silk secreted for the purpose; and during their construction a small area around each lair was swept clean, as if the animal had procured all the disposable particles fit for the erection of its residence." These little builders generally seek out well-sheltered crevices at the roots of sea-weeds, or under stones and other objects that break the wash of the waves, and there construct abodes for themselves, by scratching together any available substance within reach, and uniting it into a mass by a secretion which they elaborate.

"If we take one of these small nests, and place it under a microscope, we find that it consists, independently of the collected material, of a quantity of fine threads, closely woven and knit together, crossing each other in the utmost confusion; and here and there are seen loops formed by a single thread being doubled and spirally twisted upon itself."

Thus elegant are the contrivances whereby the humblest creatures are defended—thus exquisite the machinery employed, even beneath the silent water, to secure the due accomplishment of the Creator's will! and surely that mind must indeed be apathetic that refuses to survey such beautiful arrangements—that does not reap enjoyment and inexpressible gratification from such a scene.

"The cheerfulness of heart that springs up in us from the study of Nature's works," says Addison, "is an admirable preparation for gratitude. That mind has gone a long way towards praise and thanksgiving that is filled with such a secret gladness.

Such an habitual disposition of thought consecrates every field and wood, turns an ordinary walk into a morning or evening sacrifice, and will improve those transient gleams of joy which naturally brighten and refresh the soul on such occasions into an inviolable and permanent state of happiness. When we find ourselves inspired by this pleasing instinct, this satisfaction and complacency arising from the beauties of Creation, let us consider to whom we stand indebted for all these entertainments of sense, and who it is that thus opens his hand and fills the world with good."

We are therefore by no means disposed to permit the shafts of raillery and ridicule to insult our favourite science without remonstrance; or to allow that there is anything frivolous in a close and earnest investigation of the works of the Almighty; we rather exclaim with Cicero,—

"Cultus autem est optimus idemque castissimus atque sanctissimus plenissimusque pietatis."

Natural History is the appointed handmaiden of Religion, enabling us, instead of merely assenting to the existence of a Divine Providence, and recognizing in vague terms the fact of his beneficence, to feel, and in some humble proportion to appreciate, how closely and how carefully the well-being and happiness of all creatures has been provided for—how admirably they are severally adapted to their respective stations and employments, and how wonderfully every part of their œconomy is made subservient to the general good. This is the true spirit in

which the aquariist ought to work, and this the end and object of his science:—

"Let it be hers a voice to raise,
Like those bright hosts in yonder sphere,
Who, while they move, their Maker praise,
And lead around the wreathed year!"

CHAPTER XLII.

CIRRIPEDES OR BARNACLES.

"So slow Bootes underneath him sees,
In the Icy Isles, those Goslins hatch'd of Trees;
Whose fruitful Leaves falling into the Water
Are turn'd, they say, to living Fowls soon after:
So rotten Sides of broken Ships do change
To Barnacles: O Transformation strange!
'Twas first a green Tree, then a gallant Hull,
Lately a Mushrum, then a flying Gull."

"And from the most refined of Saints
As naturally grow miscreants,
As Barnacles turn Soland Geese,
In the Islands of the Orcades."

THE account of the Barnacle given by the sage Gerrard is a rich specimen of the natural history of the sixteenth century. Here it is:—

"But what our eyes have seen and our hands have touched we shall declare. There is a small island in Lancashire called the '*Pile of Foulders,*' wherein are found the broken pieces of old and bruised ships, some whereof have been cast thither by shipwracke, and also the trunks and bodies with the branches of old and rotten trees cast up there likewise, whereon is found a certaine spume or froth that in time

breedeth into certaine shels, in shape like those of the muskle, but sharper pointed, and of a whitish colour, wherein is contained a thing in form like a piece of silke, finely woven as it were together, of a whitish colour; one end whereof is fastened unto the inside of the shell, even as the fish of oisters and muskles are: the other end is made fast unto the belly of a rude masse or lumpe, which in time commeth to the shape and form of a bird: when it is perfectly formed, the shell gapeth open, and the first thing that appeareth is the foresaid lace or string: next come the legs of the bird hanging out, and, as it groweth greater, it openeth the shell by degrees, till at length it is all come forth, and hangeth onely by the bill: in short space after it commeth to full maturitie, and falleth into the sea, where it gathereth feathers, and groweth to a fowle bigger than a mallard, and lesser than a goose, having blacke legs and bill, or beake, and feathers blacke and white spotted in such a manner as our mag-pie, called in some places a *Pie-Annet,* which the people of Lancashire call by no other name than a tree goose, which place aforesaid, and all those parts adjoining, do so much abound therewith, that one of the best is bought for three-pence. For the truth hereof, if any doubt, may it please them to repair unto me, and I shall satisfie them by the testimonie of good witnesses*."

The belief that the Barnacles are the young or embryo state of the Barnacle Goose (*Anas erythropus*), and of the Scoter or Black Goose (*Anas nigra*), is indeed one of those popular errors which has not only

* *Vide* Herbal, p. 1587–88.

extended through several ages, but still prevails amongst the vulgar on all the shores of the European seas, and appears to have no other foundation than a fancied resemblance in the plumose members of the animal inhabitant to the wing of a bird.

One circumstance, however, which serves in no small degree to keep up this absurd error is, that in some Catholic countries the above species of geese are still conveniently considered as belonging to the finny tribe, in order to extend the bill of fare in Lent, and at other times of fasting and abstinence:—"C'est un *gibier d'eau* fort estimé: une qualité que les pieux gourmets savent apprécier c'est qu'on peut les manger dans le temps d'abstinence religieuse*."

"The bird which at Paris is called '*Macreuse*,' and in other parts of France '*Macroul*,' the French eat upon fast-days and all Lent, thinking it to be a sort of fish, or a marine animal with cold blood, or else a Barnacle generated either out of rotten or corrupted wood floating upon the sea, or out of certain fruits fallen into the water, and there metamorphosed into a bird, or else from a kind of sea-shells adhering to old planks and ships' bottoms†."

To show how far prejudice will sometimes carry men, who, from station and education, should be fortified against such delusion, we may as well add what Sir Robert Moray has said upon the same subject, in a grave communication to be found in the same work‡.

Having observed wood thrown up by the ocean on

* Article BÉNACHE, Nouv. Dict. d'Hist. Nat.

† Dr. Tancred Robinson, Phil. Trans. abridged, vol. ii. p. 850.

‡ Page 849–50, No. 84.

the shores of the Western Islands of Scotland, which were covered with Barnacles (from the figure and description probably *Lepas Anatifera*), he states that the pedicle "seems to draw and convey the matter which serves for the growth and vegetation of the little bird within it.... In every shell that I opened I found a perfect *Sea-Fowl*; the little bill like that of a *Goose*; the eyes marked; the head, neck, breast, wings, tail, and feet formed; the feathers everywhere perfectly shaped, and the *feet* like those of other waterfowl, to the best of my remembrance..... Nor did I ever see any of the little birds alive, nor met with anybody that did; only some credible persons have assured me that they have seen some as big as their fist." (!!)

Surely in those days it was not without reason that conscientious and honest men were somewhat scandalized at so bare-faced an evasion of the strict discipline of Lenten-fare, and we can readily appreciate the zealous indignation with which they protested against such irregularity in expostulatory effusions:—

"Men holden ye therefore prophanes;
Ye eaten neither shrimps nor pranes;
Salte fish, stockefish nor herringe
Is not for your wearinge;
Nor in holy Lenten season
Will ye either beanes or peason;
But ye looke to bee lette loose
To a pygge or to a goose."

The animals embraced under the term Cirripeds by naturalists are familiar to every sea-side visitor. Two

very different types, however, are comprehended under this name, viz. the families of LEPADES or true Barnacles (Pl. VII. fig. 6), and that of the BALANI or *Acorn-shells* of British conchologists (Pl. VII. fig. 5),—the former elevated on a membranous pedicle, the latter sessile, and provided with a domicile wholly calcareous: several species of both of them are amongst the most abundant and common productions of the ocean. The Balani attach themselves, for the most part, to the surface of rocks, and are consequently the inhabitants of the shore; the Lepades, on the contrary, are seldom found on *fixed* bodies, but almost always on such as float upon the surface of the sea, such as Fuci, bits of wood, and the bottoms of ships, by which means they participate in the benefits of a vagrant life.

The food devoured by the Cirripedes would seem to consist of various minute animals, generally of microscopic dimensions, caught in the water around them by a mechanism at once simple and elegant. Any one who watches attentively the proceedings of a living Barnacle when in a vigorous and active condition, will perceive that its arms, with their appended cirrhi, are in perpetual movement, being alternately thrown out and retracted with great rapidity; and that, when fully expanded, their plumose and flexible stems form an exquisitely beautiful apparatus, admirably adapted to entangle any nutritious molecules, or minute living creatures that may happen to be present in the circumscribed space over which this singular casting-net is thrown, and drag them down into the vicinity of the mouth, where, being seized by

the jaws, they are crushed and prepared for digestion. No sense but that of touch is required for the success of this singular mode of fishing; and the delicacy with which the tentacula perceive the slightest contact of a foreign body, shows that they are eminently susceptible of tactile impressions. Nothing, indeed, can be more admirable than this unique apparatus, or more efficient for the intended purpose; it reminds the spectator at once of Ariosto's giant:—

"He, 'mid the cruel horrors he intends,
Takes pleasure in a net by cunning hands
Contrived, which near his mansion he extends;
So well conceal'd beneath the crumbling sands,
That whoso uninstructed thither wends
Naught of the subtle mischief understands,
Whom with loud laughter to his seat hard by
He drags along, entangled in his snare;
Then, having suck'd their brains and life-blood dry,
Casts forth their bones upon the desert lair."

In order to account for the apparent election made by the Lepades and the Balani, as to the sites invariably adopted for their respective residences, it was at one time surmised that the eggs of the two races were of different specific gravity; that those of the Balani, from their greater density, were disposed to remain at, or sink to the bottom, while those of the Lepades, being lighter, tended to rise towards the surface, and by a glutinous property attached themselves to the first solid body with which they came in contact. There will, however, be no further occasion for the exercise of our ingenuity to account for this remarkable circumstance, when aware that in the first

state of these animals they not only possess perfect freedom and power of motion, but organs of sight, which furnish them with the means of choosing such localities as are best suited to the respective habits conferred upon them by Omnipotence, and limbs calculated to anchor them to the chosen spot; in fact, that after leaving the eggs from which they are produced, they undergo a complete and wonderful metamorphosis, the phases of which are extremely remarkable and interesting, and which, by collecting the animals at the proper season, that is, during the earlier spring months, the aquariist will have little difficulty in studying for himself, and perhaps of solving some of the mysteries with which this part of their history is still overclouded.

In the pedunculated races, the ova, after expulsion from the ovarium, appear to be conveyed by the ovipositor into the cellular texture of the pedicle (just beneath the shell-clad body), which they fill to the distance of about an inch. When first placed in this situation, they seem to be shapeless, and inseparable from the pulpy substance in which they are imbedded; but as they approach to maturity, they become of an oval figure, pointed at both ends, and are easily detached.

During the stay of the ova in the pedicle, they render this part more opaque and of a bluish tint; the eggs themselves, and the cellular texture with which they are surrounded, being of a pale or azure-blue colour.

It is difficult to conceive in what manner the ova are extricated from the situation above indicated, but

they are subsequently found forming a pair of leaf-like expansions, placed between either side of the body of the Barnacle and the lining membrane of the shells (Pl. VII. fig. 6). These leaves seem to be composed of a layer of eggs irregularly placed, and imbedded in a kind of soft texture, out of which, when mature, they readily fall on its substance being torn asunder; indeed it at length becomes so tender as to disappear entirely; so that, after the period of gestation is passed, no vestige of these leafy conceptacles is to be found.

Few things could be more startling to the inexperienced naturalist than the appearance of the young Cirripedes derived from these eggs when they are first hatched; neither could any one imagine *à priori* that they were the progeny of parents so completely dissimilar:—

> "The diabolic youngling
> Comes out no callow birth,
> Puling, defenceless, blind, and weak,
> Like bird or beast of earth,
> Or man,—most helpless thing of all
> That fly, or swim, or creep, or crawl,—
> But in his perfect figure;
> His horns, his dreadful tail, his sting,
> Scales, teeth and claws, and everything,
> Complete and in their vigour."

In this their first or larva condition the young animal is quite free and active, resembling a tailed *Monoculus* (Pl. VII. fig. 6, *a*), able to swim about vigorously; and for this purpose having three pairs of natatory limbs, the anterior of which are simple, the others bifid; it likewise has its back covered with

an ample shield, terminating anteriorly in two extended horns, and posteriorly in a single elongated spinous process; and, what is stranger still, a large, conspicuous eye, of which no vestige is traceable in the adult.

It still remains uncertain how long the larvæ of these Cirripedes remain in this, their first and free state, but it is probably for a longer or shorter period of time, according as they sooner or later meet with a support adapted to their respective habits. However this may be, sooner or later a second change of form takes place, quite as remarkable as the first; and the young Barnacle makes its appearance under a totally different aspect (Pl. VII. fig. 6, *b*).

The little creature in this condition is quite translucent, one-tenth of an inch long, of a somewhat elliptic form, and of a brownish tint. When in a state of perfect repose, it resembles a very minute mussel, and lies upon one of its sides at the bottom of the vessel of sea-water in which it is placed. At this time all the members of the animal are withdrawn within the shell, which appears to be composed of two valves, united by a hinge along the upper part of the back, and capable of opening from one end to the other along the front, to give occasional exit to the limbs. These are of two descriptions: viz. anteriorly, a large and very strong pair, provided with a cup-like sucker and hooks, serving solely to attach the embryo to rocks, stones, &c.; and posteriorly, six pairs of natatory members, so disposed as to act in concert, and to give a forcible stroke to the water; thus causing the animal, when swimming, to advance by a suc-

cession of bounds, after the same manner as the Water-flea, *Daphnia*, and other freshwater Entomostraca, but particularly *Cyclops*, whose swimming-feet are extremely analogous. The tail, which is usually bent up under the belly, is short, composed of two joints, and terminates in four bristle-like appendages; these are employed to assist in progression.

The most startling circumstance, however, in the structure of these larvæ is the possession of eyes, which, although constantly shielded by the valves of the shell, are pedunculated as in the Crab and Lobster, and placed anteriorly at the sides of the body.

Under the impression that the little creatures represented in the plate referred to were Crustaceans, perhaps in a larval state, a few of them were placed by Mr. J. V. Thompson, who first discovered and described these strange proceedings, in a glass vessel, covered by such a depth of sea-water that they could be examined at any time with a magnifying-glass; and on the 8th of May (we give the date, in order to indicate the proper season for such researches), two of them were found to have thrown off their exuviæ, and were seen firmly adhering to the bottom of the vessel, changed into young Barnacles.

On the 10th another individual was seen throwing off its shell, and attaching itself, like the others, to the bottom of the glass. As the shelly valves of the young Barnacle are formed, the eyes disappear, and the capability of vision is extinguished for the remainder of the creature's life; the arms at the same time acquiring the plumose appearance characteristic of the adult Cirriped.

Thus, then, an animal originally natatory and locomotive, and provided with a distinct organ of sight, becomes permanently and immoveably fixed, and its optic apparatus obliterated; and the Barnacle, although neither a duck-egg nor a young gosling, is thus proved to undergo a metamorphosis, not so miraculous certainly, but almost as wonderful, as that ascribed to it by our forefathers!

CHAPTER XLIII.

WHITBY.

Few localities offer more attractions to the naturalist, especially if he have a geological bias in his composition, than the vicinity of Whitby, and few remains of monastic edifices can rival the noble ruins of Whitby Abbey.

One fine autumn morning, when zoologizing in that neighbourhood, we specially remember enjoying a delightful walk on the pier there, in company with some pretty cousins of ours, whose conversation, sparkling as the laughing sea around us, lent additional charms to an already charming scene. Various were the legends, grave and gay, upon which we had to bestow our attentive ears;—how Lady Hilda, the great patron saint of that district, and the foundress of the venerable Abbey which looked down upon us from its elevated site upon the opposite side of the bay, having, like St. Patrick of Ireland, a violent detestation of snakes and other vermin, had not only turned them all into stones, but wrung all their heads off at one fell swoop, and causing them to be buried in the neighbouring cliffs, thus enriched the locality with all the "snake-stones" (Ammonites, as unbe-

lieving geologists call them), and various other curiosities to be met with abundantly in that locality :—

> "They told how sea-fowl's pinions fail,
> As over Whitby's towers they sail,
> And sinking down with flutterings faint,
> They do their homage to the saint;"—

a phenomenon, by-the-by, very irreverently accounted for by some naturalists, from the circumstance that the flocks of migratory birds, which, after their long passage across the sea, first reach the land, are in this vicinity, as in many others, so exhausted by their journey, as to be for some time incapable of further exertion, and must needs rest their weary wings, without much troubling their heads about the episcopacy of the neighbourhood.

But the most startling legend of all, and for the truth of which some of the ladies fully vouched, was that Lady Hilda was herself still to be seen, haunting the ruined pile she had so long presided over, and manifestly continuing to take a deep interest in the town and its inhabitants. Our incredulity upon this point was evidently regarded by our fair companions as a very unpardonable piece of heresy, more especially as, Whitby being our native place, such scepticism was on that account the more unjustifiable.

It happened that the evening of that day was a most inviting one for a walk:—a cloudless moon, nearly at her full, rose gloriously upon the rippling sea; and as the dirty lanes and dingy alleys of the old town consorted ill with such a state of things, we sauntered forth to climb the Abbey-steps by which you mount to the top of the tall cliff whereon the

old Abbey and its coeval church are situated. We felt that the time was propitious:—

"He that would view such ruins aright,
Must visit them by the pale moonlight,
When the broken arches are black in night,
And each shafted oriel glimmers white;
When buttress and buttress alternately
Seem framed of ebon and ivory;
When silver edges the imagery,
And the scrolls that teach thee to live and die."

There is something deeply solemn in walking through an ancient churchyard at such an hour, more especially in one so far removed above the busy turmoil of the town beneath—as we pace to and fro over the stones once trodden by the feet which now repose beneath them. Upon the present occasion everything combined to attach solemnity to the scene—more especially the death-like silence, unbroken, but rendered still more impressive by the low murmuring of the waves, which, at an awful depth below, approached the ruin-decorated cliff.

Wandering along in this contemplative mood, happening to raise our eyes in the direction of the Abbey, judge of our astonishment at seeing right before us, standing in the air, the figure of its saintly foundress, Lady Hilda—a mitred abbess, with two fingers raised as in the attitude of blessing Whitby!

Now we are not easily startled; but it must be confessed, an apparition so extraordinary and so unexpected was calculated at least to astonish the beholder, and we certainly gazed upon this remarkable vision with no ordinary feelings of amazement.

However, there it stood, gigantic in its dimensions—40 feet at least in height, suspended in mid-air, each fold of every garment quite distinct, and the whole in an attitude of benediction, just like that we see sculptured on ancient monumental brasses!

Had the phantom vanished suddenly, or been more evanescent than it was, I certainly should have been converted to my pretty cousins' faith in the actuality of Lady Hilda's nocturnal visitations to her beloved Whitby; but, fortunately, there the figure stood, and challenged observation, which soon made the matter plain enough. The moon was just behind the Abbey's oriel window, the rich tracery of which—the stony framework where the glass has been (as I took pains to convince myself afterwards by daylight)—presents the exact outline of the aërial figure, while in front of the window, the damp mists of evening formed the screen on which the image magnified was thrown. A more complete magic-lantern could not have been constructed: the unclouded moon, then nearly at her full, was the light, the oriel window the slide, the misty cloud in front the screen, and myself, to my great gratification, the spectator—a more striking phantasmagoria was perhaps never witnessed; and doubtless many a belated passenger, whose superstitious fears preponderated over his knowledge of optics, has, under favourable circumstances, had his faith confirmed in the Ghost of St. Hilda, and her attachment to those beautiful ruins.

We have not, however, on the present occasion climbed thus high for the purpose of enjoying such ghostly interviews with the departed; our business

just now is to trace from these majestic heights, a kind of chart to guide us in our future wanderings.

The marine Mollusca, which will next occupy our attention, are generally mentioned by systematic writers as inhabiting different *zones* or *regions of depth*; by which phrases are understood the several belts or spaces margining the land or occupying the floor of the sea, distinguished from each other by peculiar features, dependent on the nature of their animal or vegetable inhabitants. The working naturalist knows well, that upon any given beach, the objects he is in search of are by no means scattered confusedly or at random, but are always to be found in certain spots, the selection of their habitats agreeing with the nature of the ground, the depth of water, and various other circumstances, which the practised eye at once appreciates. So, on a larger scale, we may divide the ocean into districts, all of which have their appropriate or peculiar occupants.

Now turn we to the sea, spread wide beneath us in one broad expanse :—

> "Its colours changing, as from clouds and sun
> Shades after shades upon the surface run;
> Embrown'd and sombre now, and now serene,
> In limpid blue and evanescent green;"

and try to indicate and name the regions which it will be found useful for us to distinguish in our future excursions.

The highest of these belts is the space between the tide-marks indicating high and low water, an interval of very great importance in the marine fauna of our islands, and inhabited by numerous peculiar species

of plants, as well as animals. This is termed the LITTORAL ZONE. Its features vary with the geological, or rather mineralogical features of the coast; and its population, both as to kind and numbers, varies correspondingly.

The line of high-water there is no mistaking:—

"Here, Samphire-banks and Salt-wort bound the flood;
There, stakes and sea-weeds, withering in the mud;
And higher up, a ridge of all things base,
Which some strong tide has roll'd upon the place."

The broad bare tract of shore that intervenes between this line and the now distant water (for the tide is close upon its ebb) will represent the zone in question, which the returning waves will soon reclaim:—

"There, near the land you may the billows trace,
As if contending in their watery chase;
May watch the mightiest till the shoal they reach,
Then break and hurry to their utmost stretch:
Curl'd as they come, they strike with furious force,
And then, reflowing, take their grating course,
Raking the rounded flints, which, ages past
Roll'd by their rage, will still to ages last."

A second region is the CIRCUM-LITTORAL, or LAMINARIAN ZONE, so called from the abundance of tangles, or sea-weeds belonging to the genus *Laminaria*, that flourish in it. Vegetable-feeding shell-fish and Naked Mollusca are exceedingly numerous in this space. It is indeed highly productive of various types of animal, and also of vegetable life; its usual extent may be stated as between low-water mark and where the sea reaches a depth of about fifteen fathoms.

A third region is the MEDIAN, or CORALLINE ZONE,

occupying the space between fifteen and fifty fathoms. Sea-weeds, properly so called, are scarce within it, and absent from its greater portion; but much of it is clothed with an animal-vegetation, so to speak, in the shape of Corallines or Hydroid Zoophytes. It abounds with shell-fish, and many of our rarest and most valued kinds are procured from it.

The fourth region is the INFRA-MEDIAN, also called the region of Deep-Sea Corals, since in our seas (though not in those of the tropics) the principal stony corals, whether of zoophytic or bryozoic production, are procured from it.

We need scarcely trouble the reader to accompany us to the fifth region,—

"The dark, unfathom'd, bottomless abyss,"

unsounded by mortal plummet; its proper occupants,

"The rapid Swordfish and the ravening Shark,"

are scarcely admissible into any aquarium of ordinary dimensions, and may well be dispensed with. We will therefore now retrace our steps, and wending towards the beach, endeavour to obtain a few specimens better adapted to our present purpose.

CHAPTER XLIV.

POLYZOA—(BRYOZOA, EHRENBERG)—ASCIDIAN POLYPES.

"Seas and deserts hide millions of animals from our observation. Innumerable artificial and strange stratagems are acted in the howling wilderness and in the 'great deep,' that can never come to our knowledge. Besides that, there are infinitely more species of creatures, which are not to be seen without, nor indeed with, the help of the finest glasses, than of such as are bulky enough for the naked eye to take hold of. However, from the consideration of such animals as lie within the compass of our knowledge, we might easily form a conclusion of the rest, that the same variety of wisdom and goodness runs through the whole creation, and puts every creature in a condition to provide for its safety and subsistence in its proper station."

WELL! here we are once more upon the ocean's shore, as Sir Isaac Newton has it, picking up shells, in lamentable ignorance of the vast treasures that are hidden underneath those heaving waves;—by no means a bad exchange for the busy town behind us, where

> "Poor Nature, with her face begrimed with dust,
> Is stoked, coked, smoked, and almost choked."

There is something exhilarating in the exercise, as we scramble over the wave-worn, tangle-thatched rocks, and feel the salt spray which the "snoring

breeze" dashes into our faces as the advancing wave lashes itself to foam :—

> "Then back to sea, with strong majestic sweep,
> Rolls in an ebb yet terrible and deep."

And now we reach the farthest verge of the wide-stretching reef, and find around us piles of sea-weeds, strewn in prodigal abundance; a wild and desolate scene, where little seems to tempt our search, and from which a superficial observer might easily be induced to turn away in disappointment; and yet, in reality, a richer field for the naturalist can scarcely be pointed out than is now submitted for examination :—

> "Involved in sea-wrack, here you find a race,
> Which, science doubting, knows not where to place;"—

there is not a frond of that vast heap but is able to afford a treat to the aquariist, perhaps unparalleled throughout the overwhelming catalogue of the Creator's works :—

> "Infinite multitudes on every leaf,
> But yet too fine for unenlighten'd eye—
> Like stars whose beams have never reach'd our world."

It is easy, even without a magnifying glass, to perceive that the weeds before us are covered over in many places with parasitical growths, sometimes resembling creeping stems of the Sertulariæ described in a preceding chapter, or, as is more commonly the case, representing patches of delicate moss-like growths, spreading to a greater or less extent over their surface, or appearing not unfrequently like the "pile" of plush or of velvet. On being placed gently

in a vessel of sea-water, however, it is by no means difficult to detect, with a magnifying glass of very ordinary power, that every fibre of these moss-like patches is alive; nay, more, that it is an animal of most elaborate structure, polyp-like in form, and, like the humbler polyps, living in a cell, sometimes of horn, transparent as thin glass, sometimes with fleshy, or with earth-encrusted walls. A little further inspection shows that the polyp-shaped occupants of these cells are full of life and vivacious activity, readily, when undisturbed, protruding from the orifices of their abodes their numerous delicate and flexile arms in search of food :—

"As florets, by the frosty air of night
Bent down and closed, when day has gilt their leaves,
Rise all unfolded on their straighten'd stems *;"

but which on the slightest alarm are instantly retracted and packed up securely in their little citadel. The gentlest touch, even the modifications of the intensity of light, are sufficient to produce the retirement of these timid creatures, which thus manifestly exhibit both an apprehension of danger and a feeling of safety.

The cells, though commonly still, have a free power of motion; and when one is disturbed, it bends quickly to and fro, so as to strike one or two more; these again strike upon others, and thus, for a few seconds, all are in action, banging themselves about

* "Quale i fioretti, dal notturno gielo
Chinati e chiusi, poi che 'l sol gl' imbianca
Li drizzan tutte aperte in loro stelo."

furiously; but they soon return to quietness, and the arms, which during the commotion have been doubled up, open again.

It is really a circumstance well calculated to excite the astonishment even of the tyro in natural history in these days, and to afford convincing evidence of the vast improvements effected during the last few years in the means of research at our disposal, that numerous and conspicuous as these creatures now appear to be as subjects for microscopic examination, the details of their œconomy were utterly unknown, and their real nature even unsuspected, until about thirty years ago, when the learned eye of Ehrenberg, and the patient but ill-requited industry of Mr. J. V. Thompson, nearly at the same time demonstrated the wide distinctions whereby they were separated from ordinary polyps, and raised them to their true dignity, as forming a most important and interesting class of the Animal Creation. By the former of these eminent expositors of the works of the Almighty they were named Bryozoa *, or Moss-like animals; by the latter, Polyzoa †, or Many-animals, in allusion to the multitudinous communities in which they are found aggregated together; but by far the best name—although, unfortunately, not Greek enough for modern ears—is that proposed by their erudite historiographer, Dr. Arthur Farre, who called them Ciliobrachiata, or Cilium-armed Polyps, in allusion to what we shall soon perceive to be the most distinctive feature of their organization. Let us, however, select

* Βρύον, moss; ζῶον, an animal.

† Πολὺς, many; ζῶον, an animal.

a few specimens from the heaps before us, and having placed them in a jar filled with their native element, return to our microscope, further to elucidate their history.

Whoever wishes to study closely the œconomy of these exquisitely-constructed organisms, should be furnished with a number of glass troughs (which, with the aid of a little cement, may easily be manufactured of every variety of shape); these should be filled with sea-water, and a branch of the species to be examined placed in each, care being taken to adapt the dimensions of the trough to the thickness of the specimen; it being very desirable that no more water should intervene between the latter and the sides of the glass than is just sufficient for the purpose. The polyps, which always contract the instant that they are disturbed, will soon expand themselves, in which state many may be seen with the naked eye, and a very cursory glance under the microscope will then show which are the best adapted for observation*.

* A very beautiful Bryozoon is generally to be met with, spreading out in patches of variable size upon the exterior of mussel-shells; and as this is procurable in a living state with the utmost facility upon any coast where mussels are abundant, it will always be at the disposal of any one interested in the study of these elegant beings, more especially as portions of it can easily be detached from the shells whereon they grow, and, being transferred to a watch-glass, attach themselves to their new support, in which condition they may be readily preserved in a vessel of sea-water. Nothing can be more instructive than the examination of specimens so circumstanced: all the progress of the embryos and cells may be admirably seen, and their development watched from day to day in the most satisfactory manner.

In order to examine them satisfactorily, it is absolutely necessary that a clear reflected light should be transmitted through the object, care being taken to avoid all artificial illumination, the latter being totally inadequate to supply that delicate and perfect definition requisite for the exhibition of creatures so exceedingly minute and evanescent:—

> "Transparent forms too fine for mortal sight,
> Their fluid bodies half dissolved in light."

All things being thus arranged, there is no difficulty whatever in watching the many wonders connected with a spectacle so miraculous as that afforded by the inhabitants of the hitherto invisible colony, as each individual seems to start into existence, and disport itself with an energy and activity little to be expected in creatures apparently so uncared for and neglected.

In the more transparent species, even while the little animal remains quiescent in its crystal residence, it may be observed through the hyaline walls of its retreat contracted and doubled on itself, the tentacula compressed together, and the orifice of its habitation closed by a kind of membranous lid (Pl. VII. fig. 7), which, as the polyp rises to display its parts, unfolds like the inverted finger of a glove.

A circlet of *setæ*, or microscopic bristles of indescribable slenderness, next makes its appearance, rising out of the apex of the cell, and followed by the flexible portion on which it is set. The tentacula next pass up between the setæ, and push them asunder; while the integument of the animal is seen gradually

rolling outwards from around the ciliated polyp-like arms, until the latter have risen entirely above the top of the cell, when, the act of protrusion being completed, the tentacula separate and expand, and the cilia upon their surface commence their rapid and apparently voluntary vibrations,

"Tinged with rays of infinite colour,"

and appearing to the eye, beguiled by the velocity and regularity of their action, like strings of orient pearls.

The mechanism by which the protrusion and retraction of the polyp are effected, is somewhat complicated; and these movements are usually performed with such rapidity, especially that of retraction, that it is only by watching the animals perseveringly for several hours together, and sketching down each step of the process, whenever a momentary glance of one of them in a favourable position can be obtained, that any satisfactory idea of the precise mode of performing these operations can be realized. Under propitious circumstances, it will be seen that a very elaborate muscular apparatus is provided for the purpose, consisting of numerous bundles of delicate thread-like cords arising from the bottom of the cell, and implanted around the basis of the tentacular apparatus. No sooner has the little Polyzoon fully expanded itself, than a very lively scene commences—the neighbouring visible particles floating in the surrounding water are at once set in rapid motion, as though suddenly brought within the influence of a mighty whirlpool, terrible as the Maelström itself, and woe-

betide the animalcule races cast by mischance within the fatal circle!

The cause of the existence of this miniature Charybdis is to be looked for in the structure of the tentacula, which, when examined with a good microscope, are found to be armed at the back by about a dozen fine hair-like processes, which project from them nearly at right angles, while on either side they are richly furnished with vibratile cilia in constant and rapid motion, exhibiting a spectacle of extraordinary, we might almost say, of matchless beauty. All particles therefore which come within the reach of these ciliary currents are transmitted along the surface of the tentacles, until they are finally engulfed in the open mouth, which gapes to receive them.

Let the student, however, remember, that this ciliary apparatus is to be recognized in general only under favourable conditions, and by the aid of optical instruments of superior power and quality, although the effect produced may often be detected when the cilia themselves are imperceptible. The discovery of cilia upon the tentacula is, indeed, of very recent date; nevertheless, their presence forms the leading character whereby the Polyzoa are distinguishable from the Hydriform Zoophytes, and is invariably accompanied with an organization far more complicated than that possessed by the unciliated Polyps.

On examining the animal under the microscope, when placed in water to which a little carmine has been added, the movements of the streams of water produced by the ciliary action can be more distinctly observed. The two rows of cilia attached to each

tentaculum do not, as has been sometimes stated, give an impulse in opposite directions; but both strike downwards, and towards the mesial line of the tentaculum to which they are attached, causing a current down the centre of its internal surface, whereby the particles of carmine are carried towards the mouth. At this part all the streams converge, and thus give rise to an upward central current, by which the particles of carmine are carried outwards. None of the carmine seems to enter the œsophagus, although the particles will sometimes be found collected in considerable quantities around the mouth, before they are floated away,—a circumstance, which would indicate that these little creatures possess the power of selecting such substances only as are adapted to their nourishment.

The tentacula are united together at their base so as to form a circle, in the centre of which is situated the mouth, from whence is prolonged a capacious and highly irritable œsophagus that contracts vigorously when food is introduced into it. To the œsophageal tube there succeeds in some species (*Bowerbankia**) a contractile gizzard, the walls of which are lined with a wonderfully-constructed pavement of tessellated teeth, by the aid whereof the aliment is crushed and bruised preparatory to its admission into the proper digestive stomach, whence an intestinal canal

* The BOWERBANKIA DENSA is commonly found on *Flustra foliacea*, thickly aggregated in patches of half an inch to one inch in diameter; and will be easily procured by the industrious microscopist who wishes to enjoy the luxury of examining it.

may be traced mounting upwards along the œsophagus to terminate by a distinct orifice, situated close to the outer side of the tentacular ring. Thus, instead of being a simple bag, as in the Hydriform Zoophytes, the alimentary canal consists of pharynx or œsophagus, gizzard, stomach and intestine, all of which float freely in a visceral cavity formed by the delicate, transparent parietes of the animal, and apparently occupied by a clear fluid, wherein are lodged the delicate muscles that serve for the retraction of the creature.

The most ordinary mode of reproduction in the Polyzoa is by a process of gemmation, or budding from the common polypary or creeping stem, on which young animals in various stages of growth may always be seen, sprouting from the parent-stock (Pl. VII. fig. 7), and in these the nascent polyps may readily be witnessed through the transparent walls of their cells—

" timidly expanding into life,"

while the growth of their various organs can be traced from hour to hour, until they burst forth, and begin to exercise the functions peculiar to their species.

The Polyzoa generally are amongst the hardiest and most easily reared occupants of the aquarium. The Rev. Mr. Hincks observes, that he transported specimens from the coast of Lancashire to Exeter, a distance of three hundred miles; and although he was unable to renew the water in which they were kept, they continued to live, after their long journey, for two or three days. "At the end of that time they showed signs of a disposition to get rid of their heads —which is by no means a *suicidal* act in a *Pedicellina*,

and were therefore at once transferred to Goadby's invaluable solution."

Far be it from us to say anything in disparagement of "Goadby's solution" as a means of preserving at least the wrecks of defunct specimens; but whoever hopes to appreciate the beauties of a Polyzoon must examine it alive and in its full vigour,—

> "For alum styptics, with contracting power,
> Shrink its thin essence like a rivell'd flower."

No, no! a pickled Sylph or a potted Beroë would form objects for the microscope quite as instructive as a *Bowerbankia marinée à la Fortnum and Mason*.

Notwithstanding the complexity of structure so conspicuous in these highly organized zoophytes, it has been observed by Professor Reid, that in certain pedunculated species (*Pedicellina*) the body of the Polyzoon will fade and perish, and a new one will be reproduced in its place. A few days before this occurs, the tentacula remain permanently retracted; the body becomes opake, and at length falls off. After the lapse of a few days, however, the top of the stalk enlarges, and a minute bulb presents itself, in which the different parts of the polyp are developed, so that in time it assumes the proportions and duties of its predecessor,—a circumstance, which will enable the reader to understand how voluntary decapitation, as Mr. Hincks observes, in these creatures is not necessarily liable to a verdict of *felo de se*.

CHAPTER XLV.

FOLIACEOUS AND INCRUSTING POLYZOA, FLUSTRÆ, ESCHARÆ, ETC.

"The morning is all sunshine, the wind is blowing free;
The billows are all sparkling, and bounding in the light,
Like creatures in whose sunny veins the blood is running bright."

READER, if ever it has been thy lot, with weary head and aching heart, to turn for relaxation from the toils, the troubles and the cares of city-business, or, with the pallid cheek of those

"who wear their health but sickly,"

to find recruited strength in happy quietude and bracing exercise, no doubt thou hast been able to appreciate the luxury of such a scene as here is spread before us, and to enjoy a stroll along the shingly beach, breathing health-giving air, in search of any trifling object. The very search itself rewards the pains.

To the student of natural history, a walk along the quiet beach affords tenfold enjoyment. The works of the Creator that bestrew his path on every side are all to him familiar friends, whose gentle admonitions

cheer and harmonize his soul with happiest influence, recurring every now and then

> "Like pleasant thoughts, that o'er the mind
> A minute come and go again,"

yielding perpetual and increasing knowledge.

So now we stand upon the froth-fringed margin of the sea, and at our feet the rippling waves

> "Just kiss the shore, then sleep."

A lady, the companion of our excursion, evidently inspired by the scene, is growing poetical, and exclaims, appropriately enough—

> "How various the shades of marine vegetation
> Thrown here the rough flints and the pebbles among!
> The feather'd Conferva, of deepest carnation,
> The dark purple Slake, and the olive Sea-thong."

Yes! here they are scattered in rich variety; and among the multifarious assemblage we may likewise observe innumerable specimens of what the ladies call "White Sea-weeds," and which are likewise known as "Hornwrack" and "Sea-mats," the FLUSTRA FOLIACEA of scientific authors.

The word FLUSTRA, selected by Linnæus as the designation of these "*Sea-mats,*" is derived, as we are told, from a Saxon word *flustrian,* which signifies to weave; and any one who is familiar with the ordinary appearance of these masterpieces of Nature's loom, will readily acquiesce in the appropriateness of the name conferred upon them.

Few persons would imagine, from a cursory inspection of this very common marine production, how wonderful its structure really is; still fewer would

surmise, that in an object so unobtrusive, they were examining a microcosm that might be regarded literally as a world in miniature, the population of which is hardly to be counted, and possessing a structure, when examined under the microscope, of inexpressibly elaborate character.

"For curiosity and beauty," says the quaint author of the 'Micrographia,' "I have not, among all the plants and vegetables I have yet observed, seen any one comparable to this sea-weed. It is a plant [so our forefathers pleased to consider it] which grows upon the rocks under the water, and increases and spreads itself into a great tuft, which is not only handsomely branched into several leaves, but the whole surface is covered over with a most curious kind of carved work, which consists of a texture much resembling a honeycomb; for the whole surface, on both sides is covered over with a multitude of very small holes, being no larger than so many holes made with a small pin, and ranged in the neatest and most delicate order imaginable, they being placed in the manner of a *quincunx*, or very much like the rows of the eyes of a fly, the rows or orders being very regular, which way soever they are observed. These little holes, which to the eye looked round, when magnified appear very regularly-shaped holes, representing almost the shape of the sole of a round-toed shoe, the hinder part of each being, as it were, trod on or covered by the toe of that next below it. These holes seemed walled about with a very thin and transparent substance, looking of a pale straw colour; from the edge of which, against the middle of each

hole, were sprouted out four small, transparent straw-coloured thorns, which seemed to protect and cover those cavities." It would be difficult to improve upon a description so simple and so graphic.

The ESCHARÆ are very nearly allied to the *Flustræ* in their general structure, the principal difference between the two consisting in the nature of their skeleton or *polypidom*, which in the Escharæ is solidified by the deposit of calcareous earth in its substance, until it assumes a stony hardness, instead of remaining soft and flexible, as in Flustra. In both races the individual cells vary in shape in different species, and generally have their orifices defended by projecting spines, or sometimes by a moveable operculum or lid, which apparently answers the same purpose as the setæ of *Bowerbankia*, described in the last chapter, by defending the entrance to the cell.

Let not the reader suppose, however, that the precise and elegant structure of the surface of these Sea-mats is all that they present worthy of a naturalist's admiration; or that to pick them up as they lie discarded on the beach—

"Like ocean-weeds heap'd on the surf-beaten shore"—

is the proper way to obtain them for microscopical examination: they must be sought for in their living state far out at sea, or at the very lowest tides, growing upon their native rocks, incrusting shells, or spreading out upon the stems and fronds of Fuci. Thus procured, and kept in glasses filled with fresh sea-water, it is easy to observe the wondrous spectacle they offer for our contemplation: thousands of Polyp-

like inhabitants, protruding from as many separate cells, stretch forth their fairy arms and flash their countless cilia in the sunshine:—

> "Their glittering textures, like the filmy dew,
> Dipp'd in the richest tincture of the skies,
> Where light disports in ever-mingling dyes."

It were absurd to try to illustrate such a scene by words, or to expatiate on the multitudes that crowd these densely populated realms—for such they are! Yet, if we must descend to figures, let us try to calculate the number of inhabitants on but a single polypary.

Dr. Johnston mentions a specimen of *Flustra membranacea* (a most magnificent one certainly) five feet in length by eight inches in breadth, and estimated, by counting the cells on a square inch, that this "web of silvery lace" had been the joint production and habitation of above two millions of industrious inmates; so that this single colony on a submarine island was about equal in number to the whole human population of Scotland;—another London in miniature!

Speculations like these are manifestly puerile. We will therefore describe, after Sir John Dalyell, an example illustrative of the general œconomy of such productions, the study of which will enable the aquariist easily to recognize the principal facts connected with their history.

The *Fucus serratus*, or "*Sea-ware*," so common on our rocky shores, is frequently invested by dark, brownish gelatinous-looking patches, sometimes adhering to one or both sides of the leaves or fronds, and

occasionally encircling the stem. These patches are now and then in such profusion, that the leaf is weighed down by the accumulation of its parasitic occupants.

On plunging a small branch of the Fucus so incrusted in a jar of recent sea-water, and allowing it to remain for a little while at rest, a thin pale blue cloud will be speedily seen to hover over its dark irregular surface, which, on the slightest shock, is instantaneously dispelled, leaving the brownish fleshy substance distinct as before. This experiment may be frequently repeated. The semblance of a cloud is, however, soon perceived, by the aid of a microscope, to be caused by the simultaneous protrusion of a multitude of polyps emerging from the cells of the brown polypary, while the play of their numerous pale tentacula in motion over the darker ground produces a misty shade.

The minute and active polyps which thus crowd the surface of this parasitical Bryozoon are, in fact, so timid, that they sink into concealment on the slightest apprehension of danger, and it is only when they are relieved from their alarm that they venture again to display their tentacula (Pl. VII. fig. 8).

Viewed by a lens, the surface of the polypary, from which these little beings issue forth, is seen to be covered with numerous projections, indicating the position of so many cells, each of which has its orifice beset by fine spines; but it is difficult to see these distinctly, except in particular positions of the object.

The various phases attending the evolution of the contracted Polyzoa are easily witnessed. The rough, dark surface of the Flustra remains undisturbed until

the summit of the cell begins to project, announcing the approaching evolution of the polyp. First a very short white cylinder protrudes; and then the integument of the body, unfolding like the inverted finger of a glove, displays the exterior of the animal crowned by about thirty-five tentacula, so arranged as to form a bell-shaped cup, the margin of which is slightly everted. The form of the whole creature is elegant, light and beautiful; it rises very leisurely and gradually from the cell; but its retreat is most precipitate —it vanishes in a moment, and thus the cloud, composed of multitudes, is dissipated at once.

The largest, most vigorous and luxuriant specimens of this Bryozoon abound at low-water mark, and they generally prefer a muddy shore; some may be met with higher up upon the beach, but proportionally deteriorated as they are remote from the sea.

Such Polyzoa are, however, of difficult preservation; constant renewal of the agitated waves seems to be an indispensable lotion; otherwise a thin mouldy film accumulates upon the surface of the Zoophyte, and the polyps drop from their cells. Hence may be inferred the purpose of Nature in assigning the abode of these animals within the flux and reflux of the tide.

If vigorous specimens of this elegant Zoophyte be procured towards the end of May, or the beginning of June, and deposited in suitable vessels, innumerable active little bodies, resembling Infusorial animalcules, will soon be discovered swimming rapidly about (Pl. VII. fig. 8).

These creatures, the *gemmules* of the *Flustra hispida*, are of a pure white colour, elliptical in shape,

thin, and fringed by a border of active cilia, forming beautiful objects under the microscope. They traverse the water readily in all directions, ascending, descending, or revolving as if on an axis, with marvellous ease and most graceful evolution.

On isolating one of these gemmules, it is seen after a few days to remain stationary, and speedily to become affixed to the spot whereon it has rested. In a few days more a polyp becomes developed, displaying itself from a short tubular orifice at one extremity. Next, a wing is formed by development from the side, which is the commencement of a new cell wherein a second polyp originates, which, having attained maturity, is displayed along with its elder companion; and from the transparency of these new-formed cells, it is easy, at this period, to examine completely the form and organization of the animals within,—an advantage not permitted in the adult, owing to the darkness and opacity of the polypary. From the sides of these first-formed cells, others soon begin to sprout, which, as they become complete, and furnished with their enclosed polyps, give rise in their turn, in a similar manner, to a third generation—these again to a fourth, and so on, until the symmetrical dimensions of the leaf-like polypidom are ultimately attained by a continuance of the process.

The growth of the polyparies, which are thus densely populated, is thus seen to be effected by the progressive addition of new cells around the circumference, those occupying the margin being of course the most recently formed; and, indeed, the latter are not unfrequently found inhabited by the living ani-

mals, whilst in the older, or central ones, the original occupants have perished. Each polypidom, therefore, presents a long series of generations affixed laterally to each other; and in any portion of the series the relative ages of the individuals are indicated by the position which they occupy, each new-developed rank maintaining faithfully the pattern stamped upon its predecessors, and coinciding in the general arrangement of the preconstructed cells so perfectly as to transmit the characteristic form of their polypidom unchanging and unchangeable. Ceaselessly the laboûring millions work,

> "And still fulfil, immutably, eternal Nature's law;
> Each with undeviating aim, in eloquent silence."

As to obtaining specimens of these Polyzoa, adapted to the purposes of the aquarium, the naturalist, provided with ordinary perseverance, will find no difficulty; they are to be met with in a great variety of shapes on every coast; their range, indeed, is almost universal; all waters seem alike to swarm with their innumerable legions;—in creeks and quiet bays along our southern coasts,—

> "Or where the Northern ocean in vast whirls
> Boils round the naked, melancholy isles
> Of farthest Thulè, and the Atlantic surge
> Pours in among the stormy Hebrides,"—

they are found almost equally abundant; so that no sea-side visitors, however short their stay, but may procure for themselves a rich treat in witnessing the gorgeous spectacle which we have so feebly endeavoured to recommend to their notice.

CHAPTER XLVI.

ALCYONIDIUM GELATINOSUM—"PUDDING-WEED"—"SEA-RAGGED-STAFF."

"Fair creatures of the ocean, that reside
Happy in grottos of pure crystal, deck'd
With shining gems, and prettily sustain'd
On columns of clear glass!"

An elegant writer observes, that "there is an indescribable charm about the illusions with which chimerical ignorance once clothed every subject. Those twilight views of nature are often more captivating than any which are revealed by the rays of enlightened philosophy. The most accomplished and poetical minds, therefore, have been fain to search back into the accidental conceptions of what are termed barbarous ages, and to draw from them their finest imagery and machinery."

Far be it from us to underrate the "accidental conceptions" of our forefathers, or the "imagery and machinery" of which they have been suggestive; on the contrary, we have not unfrequently endeavoured to enliven our pages by the introduction of a few of their quaint absurdities. There is, however, something in the study of Natural History peculiarly re-

pugnant to fanciful and visionary speculations; and although we now and then can afford to smile at their folly, we are much more frequently disposed to grieve at the lamentable ignorance of which they are the legitimate offspring.

Whoever has carefully perused the works of that great renovator of modern science, Lord Bacon, will doubtless have appreciated the difficulties that he had to encounter, not merely in the establishment of the simplest principles of useful observation, but in the far more difficult task of combating the errors and falsehoods with which the student of nature was everywhere beset; errors so deeply rooted, and falsehoods so sanctioned by long toleration, that they had almost assumed the importance of truth and sound argument. The Idols of the tribe, the Idols of the den, the Idols of the market, and the Idols of the theatre, which he had to tilt against, were by no means Quixotic windmills or empty phantoms, but stubborn and obstinate antagonists, not easily to be overthrown; the dogmas of the schools were unassailable, and the false facts of the existing philosophy held the position of long-established data. It is almost impossible to believe, at the present day, how deeply implanted in the minds, even of persons pretending to be votaries of science, was the belief in fables more absurd and monstrous than ever were penned for the amusement of children in the wildest of nursery legends. Fancy the venerable old Ambrose Parè, by way of experiment poisoning four criminals in order to test the virtues of the Unicorn's horn, and thereby vainly attempting to convince his chivalric master, Henri

Quatre, that that vaunted counterpoison was inefficacious! *

It is really laughable to observe how timidly and cautiously the disciples of Bacon ventured to substantiate the simplest truths that happened to be at variance with popular prejudice. The vulgar justly regarded it as an extraordinary feat, when they were told of pearl-divers being able to remain under water so long as they were said to do by wonder-telling travellers; but the philosophers at once explained

* The physicians of the sixteenth century believed the horn of the Unicorn to be a universal antidote against all kinds of poison, and assure us, that the animal used to "dip it in the water to purify and sweeten it ere it would drink;" it is added, that for the same reason other beasts would wait to see this creature drink before them. This valuable horn was bought by kings and nobles, who appointed officers of state to immerse it in their cup before *they* drank, with full confidence in its efficacy as the guardian of royalty from all attempts of an assassin; and hence the proud position which the Unicorn now holds in this country as one of the supporters of the royal arms. The price at which so valuable a medicine was sold is almost incredible: Andrea Racci, a physician at Florence, affirms the pound of sixteen ounces to have been at one time dispensed in the apothecaries' shops for 1536 crowns, when the same weight of gold was only worth 148 crowns! During the prevalence of the great plague in London, no longer ago than the time of Charles the Second, in the year of our Lord 1666—not yet two hundred years since—the philanthropic author of the 'Loimologia' laments bitterly the excessive dearness of the Unicorn's horn, which was still regarded as an infallible remedy for that "cruell peste"; at the same time, however, congratulating himself as the discoverer of an admirable substitute for the expensive *nostrum*, in the shape of "lively toads baked to a fine powder."

how they managed to accomplish it, asserting, with the utmost gravity, that they put into their mouths a piece of sponge soaked in oil, whereby they were enabled to breathe under water! Surely, such a piece of information, as we might suppose, could only emanate from some wag on April-fool-day; and yet, listen to the cautious Hooke, in his 'Micrographia,' a work published in 1665, at the expense of the Royal Society, and bearing their glorious motto—

"Nullius in verba,"
"No argument like matter of fact is;"—

in strict conformity with which, he seems to have entered upon his researches after truth:—

"That use which the divers are said to make of it, seems, if true, very strange; but having made trial of it myself by dipping a small piece of it in very good sallet-oyle, and putting it in my mouth, and then keeping my mouth and nose under water, I could not find any such thing, for I was as soon out of breath as if I had had no sponge, nor could I fetch my breath without taking water in at my mouth."

Surely the world was astonished at this notable discovery!

Such was the condition of natural science at the period when we find the editor of Gerarde's 'Herbal' taking his early morning's walk by the sea-side, and stumbling upon a remarkable production, that forms the subject of our present chapter, and which in that antique repertory of curiosities the reader will find described in the following words:—

"This is a very succulent and fungous plant, of the

thicknesse of one's thumbe; it is of a dark yellowish colour, and buncheth forth on everie side with many unequal tuberosities or knots; whereupon Mr. Thomas Hickes being in our companie, did fitly name it Sea Ragged Staffe."

Subsequent writers have appropriated to the same substance the less heraldic designation of the "Pudding-weed," and by both these titles it is now distinguished upon many parts of our coast.

Little did worthy Dr. Johnson imagine, when he pointed out to his friend Mr. Thomas Hickes the newly-observed curiosity, what miracles lay hidden in the semipellucid walls of that glass-like mass, or that the "succulent and fungous plant," as he calls it, was in reality a colony of living animals,—as countless from their multitudes as they are admirable in the details of their œconomy; imperceptible almost to the unassisted eye, on account of their minuteness, and yet revealing under the microscope a structure surpassing even the dreams of the poet,—

> "When fancy at a glance combines
> The wondrous and the beautiful."

The ALCYONIDIUM GELATINOSUM, for so we must now call this exquisite production, is extremely common on many parts of the coast, especially after a gale, when it is frequently cast up in immense quantities. It is generally found attached to loose stones and shells in the form of soft, flexible, jelly-like masses, of very irregular shape, being rounded and smooth upon the surface, or flattened, nodulated and branched, sometimes attaining the length of two or

three feet, but ordinarily not more than about six inches long (Pl. VII. fig. 9). When a portion of this gelatinous mass is placed in a small glass trough of sea-water, multitudes of little polyps are soon observed emerging from hexagonal cells upon its surface, in such numbers as to cover it with a coating resembling the finest down, and moreover so closely set, that there seems to be hardly room for them to spread forth their tentacula. In this state, indeed, it is scarcely possible to make any observations upon them; but when a few only project, they become, from their extreme delicacy and transparency, peculiarly favourable subjects for examination under the microscope, and soon reveal themselves to be Polyzoa as elaborately organized as those inhabiting the cells of the Flustræ described in the last chapter.

In this species the tentacula are sixteen in number, and fully two-thirds the length of the body of the polyp; they are, moreover, extremely slender and flexible. When expanded, they are frequently seen to roll up closely upon themselves, even down to their base, the revolution taking place either inwardly or outwardly, and in one or more arms at the same time. These tentacles, we need hardly say, are densely covered with cilia of inexpressible delicacy, transparent, and almost as imperceptible as

> . . . . . "the fibrous cloud
> That catches but the faintest tinge of morn,
> And which the straining eye can scarcely see."

Nevertheless, the action of the tentacular cilia appears to be entirely under the control of the animal, and

they are sometimes observed completely at rest. If a portion of one of the arms be cut off, the ciliary action continues as vigorous as before, and the isolated part is carried about in the field of the microscope as though it were itself a living creature.

The addition of a small quantity of carmine to the water, wherein a few of the polyps are vigorously at work, at once reveals the existence of powerful currents rushing along the tentacula towards the mouth, which occupies the same position as in *Bowerbankia* and other Polyzoa. The stomach is not furnished with a gizzard in this species. The intestine forms a considerable elbow at its origin, and is short and wide, terminating, not, as is generally the case, near the tentacular ring, but about midway up the body, at a point opposite the base of the setæ.

During the spring season the aquariist will often be able to detect minute whitish points, which are sometimes exceedingly numerous, disseminated through the whole transparent substance of the gelatinous polyparium. If one of these points be carefully turned out with a needle, it is found to consist of a transparent sac, wherein are contained, generally, from four to six ciliated gemmules, which, as soon as the sac is torn, escape and swim about with the greatest activity, affording most interesting objects for microscopic observation (Pl. VII. fig. 9).

It would be impossible to explain the variety of motions which these gemmules are capable of executing, were it not obvious how complete is their control over the action of the cilia, which are their sole locomotive organs. Sometimes they simply rotate

upon their axis, or they tumble over and over; or, selecting a fixed point, they whirl round it in rapid circles, like moths around the flame of a candle; others creep along the bottom of the watch-glass, upon one end, and with a waddling gait, until in a short period all motion ceases, and they are found to have attached themselves to the surface of the glass, where, after the lapse of about forty-eight hours, the rudiments of a cell may be observed in process of formation, indicating the commencement of a new colony.

In these forms of Polyzoa there is moreover a second mode of reproduction, namely by *gemmation*, that is, by the development of young animals and cells in the interspaces between the mature ones; and this may readily be witnessed in every specimen. The newly-formed cells thus produced are, at first, of a triangular shape, and the nascent polyp is to be detected as a mere spot in the centre of each. As they grow, they advance outwardly, thrusting aside the circumjacent cells, until they acquire the hexagonal form of the adult, and thus enlarge the population of the colony. We find consequently in these wonderfully-constructed microcosms two distinct modes by which propagation is effected; one through the agency of locomotive gemmules, which, by the aid of their cilia, disperse the race to distant localities; and the other by a process of budding, whereby, as in the growth of leaves on a plant, innumerable inhabitants are added to the original colony, which in process of time becomes peopled by thousands, ay, even by millions of exquisitely-constructed creatures, presenting altogether a scene of life and happiness, the con-

templation of which inspires the mind with inexpressible feelings of admiration and astonishment at such a display of the handiwork of the Almighty, on a production apparently so humble in the scale of creation.

"All acts with Him are equal: for no more
It costs Omnipotence to build a world,
And set a sun amidst the firmament,
Than mould a dew-drop and light up its gem."

CHAPTER XLVII.

POLYZOA *continued*—"AVICULARIA"—"VIBRACULA," ETC.

"There are more things in heaven and earth, Horatio,
Than are dreamt of in our philosophy!"

MANY genera of the Polyzoa are furnished with remarkable accessory organs, that appear to be in some measure analogous to the "*pedicellariæ*" of Star-fishes and Sea-urchins, which must by no means be passed over in silence.

A very beautiful Polyzoon, for example, is generally to be found growing parasitically upon specimens of the *Flustra truncata* (of which abundance may be met with upon every shore in the north of England, although upon the southern coasts it is comparatively of rare occurrence), called the BUGULA AVICULARIA. This pretty polypidom is easily recognizable: in shape it assumes somewhat the form of a miniature pine, or larch-fir, rising about an inch in height by a short stem, around which the boughs are disposed rather in a spiral arrangement. The root runs superficially over the Flustra, secured by radicles. Each cell, of which this elegant arborescence consists, is occupied

by a lively Bryozoic polyp, resembling in all essential particulars those described in the preceding chapters.

The *Bugula avicularia*, however, has received its specific name from the presence of numerous remarkable organic bodies (*avicularia*) that cannot fail to attract the notice of all observers. The position and nature of these strange objects, indeed, together with the peculiar and unaccountable motions which they exhibit, have proved a source of much embarrassment to every one who has attempted their description.

The "*avicularium*" presents the strongest resemblance, as its name would indicate, to a bird's head in extreme miniature; nor is the comparison much impaired, even when it is examined by powerful magnifiers. It is always seated on the outside and about the middle of a cell; and should the branch of the Zoophyte be composed of a longitudinal series of parallel cells, it is borne either alternately on each margin of the branch, or on one margin only. When examined with a lens, it seems to consist of three distinct principal organs: first, a basis founded on, and incorporated with, the cell; next, a head connected with the basis; and in the third place, a lower mandible, which exhibits the most lively movements. In quiescence, the whole is like the head of a bird with the bill closed; but when in activity, the lower mandible opening folds back with a very wide gape (Pl. VII. fig. 10). Another joint connects the head with the basis, whereon the neck moves as in a socket. The bill opens and closes frequently, as if for the purpose of swallowing some extraneous matter

too refined for detection by human sense; like the gentleman who was always

> "Washing his hands with invisible soap,
> In imperceptible water."

The movements are of two kinds;—the whole *avicularium* sometimes bending to and fro, so that the head occasionally reclines as far back in proportion as when a bird lays its head between its shoulders. The other movement is merely the opening and closing of the lower mandible, which gapes widely, and continues thus expanded, but stationary, when the whole Zoophyte has perished.

These movements are frequently so lively, that, notwithstanding the excessive minuteness of the Avicularia, the agitation of several at once proves very inconvenient for microscopical observation. Though numerous on a specimen, not more than one individual is ever met with on any single cell. The *avicularium* is itself semitransparent; yet, further than has been described, no subordinate parts have been detected.

Here, then, is a fine subject for investigation by the sea-side inquirer:—Are these Avicularia parasites that live fixed immoveably to a certain spot? Are they an integral part of the Zoophyte? What relation do they bear to the cell, or to the polyp on which they reside? Many observers have been induced to conclude them to be of a parasitical nature; nevertheless, they are evidently integral parts of the Zoophyte, in so far as they are constantly formed along with new or reproducing portions; and it would seem

that they are not connected with the polyps, because they are often found lively and active on the sides of cells wherein there are none.

There is something very comical in the energy and earnestness with which the tiny jaws open and close, and throw themselves about; no cause being apparent in general for the outrageous gapings and eccentric jerks in which they indulge.

While watching on one occasion a piece of *Cellularia avicularis* under the microscope, the Rev. T. Hincks observed a worm pass over it and among its branches. It was almost immediately firmly grasped by one of the "Bird's-heads," and forcibly detained. In a short time one end of it was seized by another, from which, however, by its violent contortions, it extricated itself, but not without injury. The first assailant meanwhile kept fast hold, and soon two others caught the unfortunate creature at different points of its body. Thus it was held until securely pinioned; and all its efforts to disengage itself, which were most vigorous, proved unavailing. The *Avicularia* grasped the body of their victim most *viciously*, and nearly divided it. At the end of the contest the worm seemed exhausted by its struggles, and scarcely stirred, the beaks remaining firm and motionless. These strange police-officers, according to Mr. Hincks, were very systematic in their operations, and in capturing the intruder seemed to be discharging a very ordinary function; so that he thinks there can be little doubt that it is the office of these organs to defend the Bryozoon from enemies, and to arrest creatures or substances which might injure or annoy

it. They are well placed for such a purpose, as their incessant gaping and swinging must enable them readily to detect the presence of trespassers.

Mr. Gosse, in his most useful 'Manual of Marine Zoology for the British Isles' (a work indispensable to the sea-side visitor who wishes readily to identify the varied productions of our coasts), suggests that the "bird's-head appendages," by seizing passing animals and holding them in their tenacious grasp until they die, may be a means of attracting the proper prey of the Bryozoon to the vicinity of its mouth. The presence of decomposing animal substances in water, he observes, invariably attracts crowds of Infusory animalcules, which then breed with amazing rapidity, so as to form a cloud of living atoms around the decaying body, quite visible in the aggregate to the unassisted eye; and these remain in the vicinity, playing round and round, until the organic matter is quite consumed. A tiny Annelid, or other animal, caught by the "bird's-head" of a Polyzoon, and held tightly, would presently die; and though in its own substance it would not yield any nutriment to the captor, yet, by becoming the centre of a crowd of busy Infusoria, multitudes of which would constantly be drawn into the tentacular vortex and swallowed, it would be ancillary to its support, and the organ in question would thus play no unimportant part in the œconomy of the animal.

Among so many conflicting opinions and surmises, we must leave every microscopist to decide for himself; we merely state the case as we find it, simply wishing the reader as much pleasure as we ourselves

have enjoyed in watching the ludicrous movements of these anomalous productions.

With regard to the development of the "Avicularia," little has been made out. At first, they make their appearance as convex or hemispherical knobs, surmounting a simple cylindrical stem, and as growth advances progressively, the bird's-head form is gradually attained.

In some species of Polyzoa, a moveable appendage of a totally different description, named the "*vibraculum*," affords an interesting subject for microscopical observation. This consists of a hollow filament, situated at the upper and outer angle of each cell, filled with a fibrous contractile substance, whereby it is enabled to effect movements of a very remarkable character. These movements occur at irregular, occasionally very short, intervals. First, the filament sweeps downwards over all the posterior surface of the polypidom within its reach, and then returning on its former track, descends in the opposite direction. The use of this singular apparatus is at present conjectural, for its movements are quite independent of the polyp, and continue for days after its death. It has been suggested, that it may be useful, by serving to rid the Polyzoon of intruding vagrants, and to cleanse away accidental defilement by sweeping across the orifice of the cell.

Such are the principal and most instructive features of the Polyzoa met with upon our coasts; but, because we have selected only a few of the more ordinary species for the illustration of their general habits, the reader must by no means infer that the

members of this class are scantily distributed, or of trivial importance in the œconomy of Nature; on the contrary, they are to be met with under innumerable different aspects, dispersed along every coast, from

> . . . . . " the dismal shore
> Of cold and pitiless Labrador,
> Where, under the moon, upon mountains of frost,
> Full many a mariner's bones are toss'd,"

to the regions of the tropics and the torrid zone. The Corals themselves are not more abundant, neither have they left more lasting proofs of the universality of their existence

> "In the dark backward and abysm of time."

From the earliest appearance of life upon our globe,—from the Silurian rocks to the most modern deposits,

> "Through antediluvian mists as thick as London fog,"

the skeletons of the Polyzoa present themselves in rich profusion, testifying that, although "men were none" to see, much less appreciate such a spectacle, the cilia worked as vigorously upon the arms of extinct races, as on the tentacula of the Flustræ and Bowerbankiæ in our own aquaria.

CHAPTER XLVIII.

TUNICATA.—ASCIDIANS.

"I find thee apt;
And duller shouldst thou be than the fat weed
That roots itself in ease on Lethe's wharf."

THE scene is altered! Who that saw the sun go down last evening would have dreamed of such a change as this?

"Shapes rose from the ocean to greet him;
They curtain'd his bed:
Gold-tinged, like the eye of the topaz;
Blush-colour'd, blood-red;
Such blue as the amethyst hides
In the depths of her breast:—
And thus in the bosom of beauty
He sank to his rest!"

Then, all was calm and cheerful, and the peaceful sea, extended like a mirror, only served to multiply the glories of the parting day; but now, the hardy fisherman, with sail half-hoisted, hastens back to port to seek a shelter from the coming storm. The wind is up, and the dark heaving swell rolls heavily upon the beach, curling in sheets of foam, which, as they hurry onwards, seem to try to shun the maddening

fury of the waves behind. Here let us stand awhile, and contemplate the vast uproar;—look at the long array of foam-crowned billows stretching far to seaward, over which the shrieking gulls, blending their wild screams with the howling blast, wheel to and fro, as though in ecstasy, or ride triumphant o'er the yeasty waves!

See! where is now the rocky reef o'er which we clambered yesterday?—far out from land, like a black streak among the wallowing seas; its hidden ridges only traceable by yonder line of breakers, rising like a wall amidst the eddying water, which, as in desperation, hurls itself upon the craggy obstacle that dares to interrupt its seemingly resistless course:—

"And it bubbles and seethes, and it hisses and roars,
As when fire is with water commix'd and contending;
And the spray of its wrath to the welkin up-soars,
And flood upon flood hurries on, never ending;
And, as with the swell of the far thunder-boom,
Rushes roaringly forth from the heart of the gloom*."

A bad day this for the naturalist! do you say? By no means; this furious storm will save us an infinity of trouble. Let us wait awhile till the retreating tide enables us to gather up the spoils these waves have reft from their deep hiding in the Laminarian

* "Und es wallet und siedet und brauset und zischt,
Wie wenn Wasser mit Feuer sich mengt,
Bis zum Himmel spritzet der dampfende Gischt
Und Well' auf Well ohn' Ende drängt,
Und wie mit des fernen Donners Getose
Entstürzt es brüllend dem finstern Schoosse."

zone; and, trust me! we shall reap a most abundant harvest:—

> "Suave, mari magno turbantibus æquora ventis
> E terra magnum alterius spectare laborem!"

that is,—as we will take the liberty of translating it,—It is very agreeable to sit still here upon the shore, and watch the sea doing our work for us, especially while we enjoy a little luncheon.

And now the tide is ebbing, and the beach strewn with all sorts of objects left by the retreating waves: —let us to our task, and see what next presents itself for observation; for we may rest assured, the products of deep water will be met with here. And first, these large ASCIDIANS claim our notice.

Rarely is the dredge drawn up from any sea-bed at all prolific in submarine creatures, without containing few or many irregularly-shaped leathery bags affixed to sea-weed, rock, or shell, by one extremity, or by one side, free at the other, and presenting two more or less prominent orifices, from which, on the slightest pressure, sea-water is ejected with great force. On the sea-shore, when the tide is out, we find similar organisms attached to the under surface of stones, or lodged in crevices of rocks. They are variously, often splendidly coloured, but otherwise are unattractive, or even repulsive in their aspect. These creatures are ASCIDIÆ, properly so called. Numbers of them are often found clustering amongst tangles, like bunches of some strange semitransparent fruit; others are enclosed in a gelatinous case*, which is often en-

* The word Ascidian is derived from ἀσκὸς (*askos*), a leather bag, or wine-skin.

crusted with stones and shells, or decorated with parasitical, though ornamental plumes of corallines, that not unfrequently form valuable additions to the stock of the aquarium.

When we consider the fixed and immoveable condition of one of these helpless creatures, and its absolute deprivation of all prehensile instruments adapted to seize prey, it is by no means evident at first sight how it is able to subsist, or secure a supply of nourishment adequate to its support: neither is the structure of the mouth itself, nor the strange position which it occupies, at all calculated to lessen the surprise of the naturalist who enters upon a consideration of this part of their œconomy. The mouth, in fact, is quite destitute of lips, or other extensible parts, and situated, not at the exterior of the body, but at the very bottom of a capacious bag enclosed in the interior of the creature. It is obvious, then, that whatever materials are used as aliment must be brought into the body with the water required for respiration; but, even when thus introduced, the process by which they are conveyed to the mouth still requires explanation. A truly miraculous apparatus is provided for this purpose. The whole surface of the respiratory chamber is covered over with multitudes of vibratile and closely-set cilia, arranged in millions, which by their united action cause currents in the water, all of which flow in continuous streams directly towards the mouth. It is sometimes possible, in very young and translucent specimens, by the aid of a good microscope, to witness the magnificent scene afforded by these cilia when in vigorous action:—

....."salientia viscera possis
Et perlucentes numerare in pectore fibras."

The effect upon the eye is that of delicately-toothed oval wheels revolving continually from left to right; but the cilia themselves are very much closer than the apparent teeth, the illusion being caused by a fanning motion transmitted along the ciliary lines, producing the appearance of waves, each wave representing a tooth of the supposed wheel.

Whatever little substances, alive or inanimate, the entering water brings into the branchial sac, if not rejected as unsuitable, lodge somewhere on the respiratory surface, along which each particle travels horizontally, with a steady, slow course, to the front of the cavity, where it reaches a downward stream of similar materials, which hurries onward, receiving accessions from both sides, until at last the whole is brought into the gaping mouth.

The food of these creatures, indeed, appears to consist entirely of vegetable organisms, principally *Desmidiæ, Diatomaceæ*, and other microscopic forms which abound in their native element, and are constantly poured in shoals down their throats by the amazing machinery we have just been describing.

Impassive and rudely shaped as the Ascidians seem, a close examination shows that some of them are by no means destitute of instruments of sensation; and to some species the possession of eyes has been attributed by observers of well-established reputation; these consist of six or eight red specks arranged round each of the two external orifices of the sac-like envelope, and which are stated by some anatomists to

present in their internal structure a set of lenses, and all the parts necessary for distinct vision. It is certainly hard to conjecture of what use eyes can be to creatures so circumstanced; and yet, who knows of what indolent enjoyment they may be capable? Do they

> "In coral bowers love to lie,
> And hear the surges roll above,
> And, through the waters, view on high
> The proud ships sail, and gay clouds move?"

We leave the reader to his own speculations upon this subject.

The next great puzzle that suggests itself relative to the œconomy of the Ascidian Mollusca is the mode in which they are propagated and dispersed throughout the seas; for surely it would be difficult to point out any race of beings less adapted by their habits and sedentary character to the dissemination of their species. They might lay eggs, it is true, and those eggs, consigned to the tender mercies of the waves, might be washed about hither and thither, the sport of chance; yet even thus the helpless progeny would find it difficult to gain a resting-place, were they, when hatched, as limbless and as senseless as their parents. Here comes another prodigy; for, wondrous to relate, although the parent is as still and motionless as the dull weed to which we have compared it, the young Ascidian at its birth presents itself in the shape of an active, seeing, wriggling, swimming thing, well able to disport itself, and choose at will a resting-place where to attach itself for life.

For one of the earliest accounts of the extraordinary

metamorphosis whereby this is effected, we are indebted to Sir John Dalyell; and consequently, although later researches have since filled up the outlines of his description with many elaborate details, we shall lay before the reader the original sketch, which may well serve as a model for the observant naturalist:-

"Having obtained a quantity of heterogeneous collections from the sea about the middle of summer," says Sir J. Dalyell, "I discovered for the first time a minute reddish animal, nearly a line in length, resembling a common pin, such as is used in apparel, which was endowed with considerable activity. It disappeared suddenly without exciting much surprise; however, for the purpose of recognition, a rude drawing had been made of it, and it was denominated '*Spinula,*' from its peculiar shape.

"Exactly five years afterwards, a similar animal again made its appearance; and it was with some surprise that I found this to be precisely on the same day of the year, the 19th of July. The coincidence being remarkable, demanded more sedulous attention. I acknowledge that I felt rather disposed to consider the object an early stage of some foliaceous or carnose Zoophyte, than as pertaining to anything else, providing it were not itself a perfect animal."

The "*Spinula*" bears the strongest resemblance to the shape of a common tadpole. A large head, almost opaque, with a black internal speck, declines into an attenuated flattened tail, by the aid of which it wriggles through the water. There was in another tank a whole colony of these *Spinulæ,* and many were

preserved, correct delineations having been made of several of them. They all disappeared just as the former had done; but this time it was observed that various minute circular spots made their appearance, not unlike those which generally indicate originating Zoophytes, and these remained on the internal surface of the vessels wherein the *Spinulæ* had been confined.

In subsequent observations, the *Spinulæ* having continued healthy, active, and vigorous for a certain time, some of them were seen with their heads applied to the bottom of the vessel, the tail being upright and stationary, as if they were enjoying a state of perfect repose in this inverted erect position. Meantime, the front may be observed to be enlarging; it seems hollow; the margin at the same time dividing into angular projections; and incipient adhesion to the glass ensues. Now the animal is no longer tranquil; its violent struggles testify that it is unwittingly or unwillingly arrested; its exertions are vehement to be free. At this juncture the vibrations of the tail become so rapid, that, like those of a cord in tension, its figure is hardly discernible by the eye; at length quiescence follows, some diffusing matter escapes from the margin of the flattened head, and the Spinula is rooted irreversibly to the spot. A dark, solid nucleus is substituted for the adhering head; the tail has vanished; a transparent marginal diffusion surrounds the front where applied to the glass, towards the circumference of which are distributed numerous flattened radicles diverging from the nucleus as from a centre (Pl. VIII. fig. 4).

As the nucleus consolidates, two nipples with

quadrangular orifices rise from the surface, while the radicles below, gradually attenuating, disappear from view. A complete metamorphosis has been accomplished;—the *Spinula* has become changed into an Ascidian resembling the *Cynthia aggregata*, so frequently met with upon our coasts.

The CYNTHIA AGGREGATA is the most common of any of the tribes occupying our seas. Almost every substance becomes readily, and often profusely invested by it. Vegetables, zoophytes, wood, shells, rocks and stones serve alike for its abode, and upon these it fixes itself, either solitarily, or associated in groups. It is an elegant, and, at all events, a harmless occupant of the aquarium, requiring but little attention except during the summer months, at which season, whoever is desirous of tracing the history of the Spinulæ and their strange metamorphosis, should attentively watch for their appearance. There is an old Spanish proverb, which says, "Lo que no acaece en un año, acaece en un rato,"—What does not happen in a year may happen in an instant; and accordingly, during the months of June and July, a few specimens of these Ascidians, kept apart in small vessels, should from time to time be carefully examined with a lens, and their offspring transferred to watch-glasses for the purpose of microscopic examination.

The CYNTHIA AMPULLA, "*The Woolly Ascidia*," unlike the generality of the race, is not affixed by the base to any foreign substance; it is free. Its dwelling is in deep water, among sand at the bottom of the sea, and it is usually caught by the lines of the fishermen;

though not, as it would seem, from seizing the bait. The animal is round, from four to four and a half inches in length, and of a reddish-brown colour, the interior of the orifice being scarlet. Whether the posterior extremity is sunk amidst the sand in its natural state, and the other end disengaged above, has not been ascertained. In captivity it always lies horizontally, without any effort either to penetrate downwards, or to shift its position.

The Ascidia intestinalis (Pl. VIII. fig. 5) bears some resemblance to a Florence oil-flask, with two necks of nearly equal dimensions, and is occasionally met with three or four inches in length; its appearance is translucent, soft, and delicate. The ordinary habitation of this species is between the valves of old oyster-shells, wherein a group of five or six may sometimes be discovered closely packed together. But by rending such double shells asunder, the Ascidiæ are often much injured; for they are generally firmly adherent by a large portion of their sides to both valves, instead of being fixed by the base, as is generally the case in other species. Laceration or abrasion is always fatal to the Ascidian.

The young are nearly transparent, and consequently well adapted for microscopic observation. Almost the whole alimentary canal is frequently visible, occupied by the muddy mass from which subsistence is eliminated.

CHAPTER XLIX.

COMPOUND ASCIDIANS.

"Millions and millions on these banks he views,
Thick as the stars of night."

It is a pleasant evening, and we will again resume our strolls upon the beach.

"How calm, how beautiful comes on
The stilly hour, when storms are gone;
When warring winds have died away,
And clouds beneath the glancing ray
Melt off, and leave the earth and sea
Sleeping in bright tranquillity!"

If, when thus walking upon the sea-shore about the line of low-water mark, our readers will take the trouble to turn over large stones, or look carefully under projecting eaves of rock, they are almost sure to find—occasionally in considerable abundance—translucent jelly-like masses, sometimes nearly uniform in tint, sometimes beautifully variegated, and very frequently ornamented as if with stars of gorgeous device, encrusting the surface of the stone, or depending from it in icicle-like projections.

"These islets on the living rock
Are of a thousand shapes,
And Nature, with her various tints,
Diversifies their thousand forms:
For some are green, like moss;
Some ruddier tinged, or grey or silver white;
And some, like yellow lichens, glow with gold;
Some sparkle sparry radiance to the sun,
As gush their fountains up."

These are COMPOUND ASCIDIANS, of which, for the guidance of the young aquariist, we have figured one or two examples (Pl. VIII. figs. 1 & 2). A tangle, or broad-leaved Fucus, torn from its rocky bed, or gathered on the sands, where the waves have cast it after a storm, will often show us similar bodies, mostly star-figured, investing its stalks, winding among the intricacies of its roots, or clothing, with a glairy coat, the expanse of its foliated extremities. If some of these gelatinous masses be removed alive in a vessel of sea-water, and placed in our aquarium, we find them lie there apparently as apathetic as sponges, giving few signs of vitality beyond a slight pouting-out of sundry tube-like membranes surrounding apertures which slowly become visible on their surface. A closer and more microscopic examination, however, teaches us that they are by no means so inanimate as they appear, but that, at all the apertures above alluded to, currents of water are in rapid motion*: streams ejected and whirlpools rushing in, indicate, that however torpid these creatures may seem to ordinary observation, all the machinery of life, respiratory wheels and circulatory pumps, are hard at work, concealed in their inmost recesses.

In the course of our examination, especially if a little dissection be employed, we find that it is not a single animal that lies before us, but a multitude of beings, all bound together by common and vital ties. Each star is found to be a family; each group of stars a community. Communities are linked together in systems, and systems are combined into masses. Every member of the commonwealth has its own peculiar duties, but shares also in operations which relate to the existence and well-being of the entire organism. There is great diversity of arrangement observable in different races, all of which, close inspection shows to be extremely beautiful; indeed, few creatures among the lower forms of animal life exhibit such exquisite and kaleidoscopic patterns as those which we see displayed in the surfaces of these jelly-like substances. The individual animals composing one of these elegant colonies (Pl. VIII. fig. 2, *a*), notwithstanding their minute size, are found, when examined anatomically, to be constructed in every respect upon the same plan as the Simple Ascidians described in the last chapter; each member of the community, however extensive, being complete in itself, although organically conjoined with its neighbours by means of the common fleshy substance in which they are all imbedded; but this is only during the adult period of their existence, for they, like the preceding, undergo a metamorphosis prior to their final fixation, which, to the aquariist, will afford abundant scope for exercising his talents of observation. We will try to lay before him what is at present known concerning this portion of their history.

When the egg of one of these Compound Ascidians is first hatched, the young progeny is seen to resemble almost exactly a newly-born tadpole, which soon extends its tail, and begins to swim about by the aid of its undulatory movements. The tail is proportionately large, and, like the body, is composed of two distinct parts, the one superficial, colourless, and of a gelatinous texture, the other central and yellow. These larvæ, after swimming about with an active wriggling motion for a few hours, attach themselves to the surface of some foreign object; and if disturbed from their position, set off and swim about as before, until they meet with a suitable situation. Having done so, their activity ceases, and they become permanently fixed, their size at this period being about that of the head of a very small pin. They appear to affix themselves to their resting-place by means of some minute suckers situated upon their anterior extremity.

When once attached, the tadpole-like larva soon loses all power of locomotion, and quickly undergoes a strange kind of change in its configuration; its body becomes wide and sac-like; its long tail, which previously played so important a part, is found entirely reduced to its gelatinous or tegumentary portion; and speedily even this, becoming more and more transparent, withers, and is finally detached, or falls away in shreds, and totally disappears. These changes ordinarily occur within the space of from ten to twelve hours; and if the larvæ are examined towards the close of the first few days of their sedentary existence, they will be seen to present the appearance

and structure of the Simple Ascidians described in the last chapter.

The Compound Ascidians during the earliest period of their development are thus seen to be solitary, swimming about like tadpoles in search of a suitable locality whereon to fix themselves, while subsequently they are found under various forms, grouped together in colonies composed of very numerous individuals. The next question, therefore, which presents itself for solution is relative to the manner in which these groups are established, and how the numerous individuals thus associated become arranged after a pattern so decided and constant in each species.

Various hypotheses have been framed by different naturalists to account for this remarkable phenomenon. In dissecting the *Botrylli* (Pl. VIII. fig. 1), M. Savigny remarked a multitude of little membranous tubes, slightly dilated at their extremities, surrounding the margins of the stellate groups; but, as his observations were confined to specimens preserved in spirits, this indefatigable observer was unable to do more than indicate the existence of such minute filamentary processes. Milne-Edwards, however, while prosecuting his examinations on living animals, sufficiently transparent for the purpose, soon convinced himself that each of these marginal appendages is in reality a little tubercle, or rather bud, developed upon the surface of the abdominal portion of the adult Ascidian, which, as it becomes gradually elongated, assumes the appearance of a tube having its free extremity closed; whilst, by its opposite end, it remains in communication with the animal from

which it sprouted, insomuch that the circulating fluids of the latter penetrate freely into the new offshoot, wherein a very perceptible circulation is apparent. As these marginal tubes extend into the common tegumentary tissue wherein the original founder of the colony is imbedded, they divide regularly into several branches, each of which becomes gradually dilated, and soon exhibits in its interior the rudiments of a new animal, in every respect resembling the other Ascidians that inhabit the common mass. Ultimately the communication between the parent and the newly-formed individual becomes obliterated; but still the progeny derived from the same branch, remaining united by their pedicles, present that determinate stellate arrangement which is characteristic of their race.

It is really wonderful to find, in animals thus apparently helpless and incapable, a structure so complex as that presented by these minute beings: doubtless, senseless and apathetic as they seem, they enjoy existence, and have some dim perceptions of the external world; at least,

> "To taste the freshness of heaven's breath, and feel
> That light is pleasant, and the sunbeam warm."

At all events, in their embryo and wandering condition, they evidently select localities adapted to the exigences of the future colony, that seems to flourish best in agitated water,—

> "On pebbly banks that Neptune laves
> With measured surges loud and deep,
> Where the dark cliff bends o'er the waves,
> And wild the winds of autumn sweep."

They are, however, not all of them of such sedentary habits; in one remarkable genus, sometimes, though rarely, met with upon our coasts, the *Pyrosoma* (Pl. VIII. fig. 3), or, as the word is literally translateable, the "body of flame," each seeming individual is, in fact, a little colony of Ascidians, every one lodged in its own cell, distinct, and yet inseparably connected with its fellows. Collected into the figure of a gelatinous cylinder, open at one extremity and closed at the other, these strangely compound beings float in the seas like meteors of this lower world, shedding around them a halo of light, brilliant indeed, but surpassed in beauty by the gorgeous colours which it serves to disclose; colours that come and go at pleasure, glorying, as it were, in their subtle changes, passing rapidly from a lively red to aurora, to orange, to green, and to azure-blue; —a magic scene, compelling more than the admiration of every beholder:—

> . . . . . "the fair star,
> That gems the glittering coronet of morn,
> Sheds not a light so mild, so powerful."

"Only imagine," says Humboldt, "the superb spectacle which we enjoyed some days ago, when, in the evening, from seven to eleven o'clock, a continuous band of those living globes of fire passed near our vessel, some of them giving out, while swimming beneath the surface of the sea, a circle of light of a foot and a half in diameter, by which we could distinguish, at a depth of fifteen feet, tunnies and other fishes, which have followed us for several weeks."

Mr. Thompson has given an interesting account of the same species:—"It presents itself to the astonished voyager under the appearance of thick bars of metal of about half a foot in length, ignited to whiteness, scattered over the surface of the ocean. Some assume the luminous state, and continue so as long as they remain in view; while in others the luminosity declines and disappears. The greater number of these apparently incandescent masses pass close to the sides of the vessel, or follow in her wake, their phosphorescence being called into activity by coming in contact with her prow, as that of such as are more distant appears to be by the conflict of the waves. The light appears to pervade the whole substance of the animal, and, when examined near at hand, varies in intensity and in shade, often exhibiting a beautiful phosphorescence, of a bluish or greenish tinge, like a pale sapphire or aquamarine, as it gradually fades away. Agitation or friction renews it as long as the Pyrosome continues to exhibit signs of life; but it is most vivid when the animal is first drawn up, and at length can scarcely be called forth by the rudest treatment."

We can scarcely promise our readers an opportunity of viewing the Pyrosome as an inmate of the aquarium, at least in these latitudes. In the Mediterranean, however, it is common enough, and many a happy hour have we spent in the contemplation of its glorious effulgence.

CHAPTER L.

SALPÆ.

"Glorious Sea! This earth has not a plain
So boundless or so beautiful as thine!
The eagle's vision cannot take it in:
The lightning's wing, too weak to sweep its space,
Sinks half-way o'er it, like a wearied bird:
It is the mirror of the stars, where all
Their hosts within the concave firmament,
Gay marching to the music of the spheres,
Can see themselves at once."

DURING calm weather in the summer-time, the sea-side visitor, who is in the habit of making boat-excursions to a little distance from the shore, may often see gliding past him lengthy chains of most translucent delicacy, the progress of which through the water on a bright day may sometimes be recognized by the rainbow-tints that seem to play around them, although, otherwise, their presence would hardly be suspected, even in the clearest water. On carefully capturing one of these elegant productions of the ocean, and examining it in a glass vessel filled with its native element, it is found, to the surprise of the beholder, to be entirely made up of numerous distinct animals united together, after various patterns in

different species, all of which are extremely beautiful: some form a lengthened ribbon, composed of numerous individuals placed side by side, and hence arranged transversely; others again form chains, in which each component member is stretched in the direction of its length, and attached to the one before and the one behind it; while some, like the specimen we have figured (Pl. VIII. fig. 6, *b*), are agglutinated, as it were, in two parallel rows.

When taken out of the water, the links of the chain fall asunder, owing to the several distinct animals of which it is composed losing their power of adhesion; and broken-up chains, and separated members of such communities, are not unfrequently met with in seas where the Salpæ are numerous.

But other Salpæ are also to be found, very dissimilar in form from the preceding (Pl. VIII. fig. 6, *a*), which are never united together in chains, and might easily be looked upon as belonging to a distinct race, but which have been proved by recent discoveries to be in reality the parents and the progeny of the concatenated individuals; the offspring of these solitary Salpæ being united together in long ribbons, such as we have already described (Pl. VIII. fig. 6, *c*), which in their turn give birth to isolated animals; in other words, the chained Salpæ do not produce chained Salpæ, but solitary Salpæ, which in their turn give birth, not to solitary beings, but chained; consequently a Salpa-mother is not like its daughter, or its own mother, but resembles its sister, its granddaughter, and its grandmother. These remarkable animals are most difficult subjects for observation:

whilst swimming in their native element, indeed, such is their transparency, that, without profiting by every change of light, their very existence might easily escape the notice of an incautious observer, and it is only after long and most careful study, that their beautiful structure reveals itself to the astonished naturalist: attentive examination, however, shows that their delicate bodies are translucent cylinders, open at both ends, each cylinder being made up of two membranes, whereof the outer one is tough, and possessed of little vitality, while the internal, of softer consistence, is eminently contractile. The apertures, situated at each extremity of the body, allow free passage to the surrounding element, which permeates the animal from end to end; and as one of the terminal orifices is provided with a valve, that, while it allows free admission to the entering water, prevents its return through the same channel, it is, by the contractions of the muscular walls of the body, ejected in forcible streams out of the hinder orifice, thus giving an impulse whereby the creature is enabled to propel itself through the water. In the long, chained forms that swim through the calm water with regular undulatory movements, the individuals of which they are composed appear to contract and expand simultaneously, keeping time like a regiment of soldiers marching; each chain seems consequently to be a single animal, and hence the sailors often speak of them familiarly as sea-serpents.

We have already alluded to the crystalline transparency which renders the Salpæ almost undistin-

guishable, even in a small vessel of the most limpid water:—

> .... "the fibrous cloud,
> That catches but the faintest tinge of even,
> And which the straining eye can hardly seize,
> When melting into eastern twilight's shadow,
> Is scarce so thin, so slight."

They are, nevertheless, exceedingly beautiful objects, and, in a favourable light, splendidly iridescent:—

> "Mille trahens varios adverso sole colores."

Their hues of rainbow-light glow like the gleams of an air-bubble in the sunshine, presenting tints which scarcely find comparison on earth; and during the night, many of them are, under certain circumstances, brilliantly phosphoric; nevertheless, they appear to emit their phosphorescent flame only when the water is agitated, or when they come in contact with opposing bodies. In his observations on one of these creatures, Mr. Beaufort says,—"On holding a Salpa in my hand, and gently pressing it, a faint flame seemed to pervade the whole inside, and on each projecting point there seemed to stand a little globule of very vivid light. On increasing the pressure, its brilliancy likewise increased for a few moments, then gradually declined for some time, as if exhausted by the exertion. It may have been fancy, but at the time I was convinced that it gave out a sensible degree of warmth to the hand." The latter observation, says Dr. Johnston, is probably not fanciful, but real; for Humboldt has proved that the Salpæ, as well as the Pyrosomes, when preserved in a bottle, make the temperature of the water rise nearly one Centigrade degree.

CHAPTER LI.

"THE SCALLOP-SHELL."—THE MUSSEL AND THE LIMA.

"What print of fairy feet is here,
On Neptune's smooth and yellow sands?
What midnight elves in airy dance,
Beneath the moonbeams' trembling glance,
Have chased the waves, uncheck'd by fear?
Whoe'er they were, they fled from morn;
For now, all silent and forlorn
These tide-forsaken sands appear."

It by no means follows, that because the marine aquarium has but recently found a place in the drawing-room of the amateur naturalist, or vindicated for itself a claim to be considered as ancillary to the pursuits of the scientific inquirer, it is a novelty in the world, as rows of oyster-tubs on every fishmonger's stall abundantly testify; neither are the contents of those wooden *piscinæ* without numerous admirers, anxious to discuss the merits of their native occupants, and enjoy the luxury of more familiar acquaintance with the interior of the well-known bivalves, so far at least as to be able to estimate with critical gusto the relative merits of such epicurean delicacies. Further than this, we believe the public

interest does not generally extend. Sooth to say, there is little in the external appearance of an oyster to kindle enthusiastic admiration. It is anything but a cheerful companion; and were all its conchiferous brethren equally motionless and apathetic, their presence in the aquarium could perhaps very well be dispensed with.

Fortunately, however, this is by no means the case; on the contrary, many of the Bivalve Mollusca are exceedingly vivacious, and from the vivid beauty of their colours, calculated to adorn, as well as to enliven, the scene of their operations; insomuch that we feel ourselves tempted to select at least two or three examples illustrative of their œconomy.

The PECTEN or "SCALLOP-SHELL" (Pl. VIII. fig. 9) derives its Latin name from the longitudinal markings with which its surface is covered having some resemblance to the teeth of a comb, that is to say, of certain kinds of combs, which, in obedience to the revolutions of fashion, at intervals make their appearance. Their colours are often extremely beautiful; and from this circumstance, as well as from the elegance of their shape, they have always been favourite subjects both for painting and sculpture. Neither are they without their heraldic significance:—

> "For the scallop shows in a coat of arms,
> That, of the bearer's line,
> Some one in former days hath been
> To Santiago's shrine."

"The scallop-shell," says Fuller, "(I mean the nethermost of them, because most concave and most capacious,) was often cup and dish to the pilgrims in

Palestine, and thereupon, their arms they always charged therewith*."

It is, however, rather with the internal œconomy of these bivalve races, than with their external decorations, that we wish at present to occupy the attention of our readers, and therefore claim indulgence for a brief period, while we endeavour to illustrate the principal features of their organization.

On separating the two valves (Pl. VIII. fig. 9, *a*), we at once perceive that each of them is lined with a thin and transparent membrane, which, like the shells, encloses the body of the mollusk, in the same way that the leaves of a book are contained between its covers. These lining membranes of the shell constitute the *mantle*, the circumference of which is in

* The scallop-shell appears to have legitimately belonged only to pilgrims to the celebrated shrine of St. James at Compostella in Spain, as may be gleaned from the following legend:—

The ship in which the body of St. James was conveyed to its last resting-place happening to draw near the coast during the performance of certain nuptial festivities, the bridegroom's horse becoming ungovernable, plunged into the sea, and, together with its rider, sunk; but at the moment the ship was passing by, rose again, close along-side of it. There were several miracles in this case. The first was, that the sea bore upon its waves the horse and horseman as if it had been firm land, after not having drowned them when they were so long under water. The second was, that the wind, which was driving the ship at full speed into port, suddenly fell, and left it motionless; while the third, and most remarkable, was, that both the garments of the knight and the trappings of his horse came out of the sea covered with scallop-shells, which were afterwards enjoined to be worn in commemoration of the event.

this case quite free and unconnected, except in the immediate vicinity of the hinge. The borders of the mantle are thickened, and surrounded with a delicate fringe of retractile filaments; they, moreover, present a decided glandular appearance, and secrete colouring matter of various tints, similar to those seen upon the exterior of the shell; the glandular margins of the mantle form, in fact, the apparatus whereby the extension, as well as the ornamentation, of the shell is effected.

Between the layers of the mantle are seen the *branchiæ* or *gills*, always consisting of four delicate leaves, composed of parallel fibres of exquisite structure, attached to the circumference of the body by their fixed extremities, but elsewhere perfectly free, so as to float loosely in the water, which, when the shells are slightly opened, finds free admission to them.

The mouth is situated between the two inner laminæ of the branchiæ, in a kind of hood, formed by the union of the gills in the vicinity of the hinge: it is a wide orifice, without any kind of dental apparatus, but bordered by four thin and membranous lips, a pair of which is situated on each side of the aperture.

The valves are opened by the elasticity of a compressible ligament interposed between them, and are closed by the contraction of a powerful muscle, that passes directly from one to the other, while around this the rest of the body is disposed. In the neighbourhood of the oral aperture is placed a retractile fleshy organ, which, although in the Scallop it exhibits

very rudimentary dimensions, expands in other species to such a size as richly to merit the name of the "foot," whereby it is generally designated, and which we shall see, in a subsequent chapter, playing a very important part in the œconomy of these animals.

Whoever for a moment reflects upon the arrangement of the breathing apparatus in these bivalves, and the position of their mouth, consisting, as it does, of a simple orifice, unprovided with any prehensile organs, must perceive that there are two circumstances connected with the œconomy of a conchiferous mollusk, and those not of secondary importance, by no means easily accounted for. It is, in the first place, absolutely essential to the existence of these animals that the element in immediate contact with the respiratory surfaces should be renewed as rapidly as it becomes deteriorated, or suffocation would inevitably result from the inadequate supply of freshly aërated water; to secure which, especially when the valves are shut, no adequate provision seems to exist. Secondly, it is natural to inquire, how is food conveyed into the mouth? for, in an animal, quite deprived of any means of seizing prey, or even of protruding any part of its body beyond the margins of its abode in search of provision, it is not easy to imagine by what procedure a due supply of nutriment is secured. Wonderful indeed is the elaborate mechanism employed to effect the double purpose of renewing the respired fluid and feeding the helpless inhabitants of these shells! Every filament of the branchial fringe, when examined under a powerful microscope, is found to be covered with countless

cilia in constant vibration, causing by their united efforts powerful and rapid currents, which, sweeping over the entire surface of the gills, hurry towards the mouth whatever floating animalcules or nutritious particles happen to come within the limits of their action, and thus bring streams of nutritive molecules to the very aperture through which they are conveyed into the stomach,—the lips and labial fringes acting as sentinels to admit or refuse entrance, as the matter supplied is of a wholesome or pernicious character. So energetic, in fact, is the ciliary movement over the whole extent of the branchial organs, that if any portion of the gills be cut off with a pair of scissors, it immediately swims away, and continues to row itself in a given direction as long as the cilia upon its surface continue their mysterious movements. The tenuity of the individual cilia is indescribable,—

"Fine as Arachne's thread or gossamer;"

while, such is the velocity of their movements, that it is only by their effect upon the surrounding water that they are at all distinguishable,—

"Like that spun vapour when 'tis pearl'd with dew."

Around the margin of the mantle is arranged a row of greenish, metallic-looking lustrous beads, emulating in their brilliancy so many gems, and indeed by no means unlike those precious stones familiarly known as "cat's-eye diamonds." The nature of these glowing specks remained completely problematical until Poli, after much elaborate research, pronounced them to be visual organs, and conferred upon the animal

the name of 'Argus,' the gentleman so bountifully furnished with eyes, that some of them were always awake*; and certainly, if eyes they be, they are placed in the only position in which they could be made available as optical instruments.

Some of the Scallops are able, by a series of spasmodic flittings, to jump about vigorously; nay, if we are to believe some authors, they will occasionally leap out of the pot in order to escape from being boiled, a feat which they accomplish by a sudden strong effort to close their valves after the shells have been opened to the utmost. When deserted by the tide, it is said they will tumble forward in this way, until they have regained the water. Some writers even assert, that by flapping their valves with a very quick motion, they can rise up from their beds in the deep, and navigate the surface, having one shell raised, and disposed so as to catch the breeze in its concavity, while the other serves as a boat†. How far this account may be true we know not, although we think it probable the sailing part of it is an exaggeration; there can, however, be no doubt of the locomotive capabilities of the Pecten, at least in

* "Centum luminibus cinctum caput Argus habebat,
Inde suis vicibus capiebant bina quietem;
Cætera servabant, atque in statione manebant."

† "So the emperor Caligula,
That triumph'd o'er the British sea,
Engaged his legions in great bustles,
With periwinkles, prawns and mussels,
And led his troops with furious gallops
To charge whole regiments of scallops."

the earlier stages of its growth. The Rev. David Landsborough writes thus:—"We observed on a sunny September day, in a pool of sea-water left on Stevenston strand (Ayrshire) by the ebbing tide, what we at first thought some of the scaly brood at play. On close investigation, however, we found it was the fry of *Pecten opercularis*, skipping quite nimbly through the pool. Their motion was rapid and zig-zag, very like that of ducks in a sunny blink rejoicing in the prospect of rain. They seemed to have the power of darting like an arrow through the water, by the sudden opening and closing of their valves. One jerk carried them some yards, and then by another jerk they were off in a moment on a different tack. We doubt not, that when full-grown, they engage in similar amusements; though, as Pectens of greater gravity, they may choose to romp unseen and play their gambols in the deep."

Many bivalve mollusca possess the power of fastening themselves to foreign objects by means of tenacious threads, formed by the agency of their "foot;" and as the Scallop is not a very favourable subject for enabling the young naturalist to study this part of their œconomy, we should recommend the addition of two or three specimens of the common mussel (*Mytilus edulis*) to the stock of the aquarium, as, by observing them under favourable circumstances, the reader will be enabled readily to witness their mode of proceeding whilst employed in the construction of these elegant anchors. Opening their valves, the foot will be seen to be protruded with various strains and stretches, and gradually thrust out, until the elongation

is carried to the desired extent, sometimes fully two inches. It is next employed in feeling or testing all the objects within reach, moving backwards and forwards, or to the right and left, apparently to ascertain the security of the intended holdings. The point of the foot is then settled, and retained for a short time on the chosen spot, when it is again suddenly removed and immediately withdrawn entirely within the shell, leaving behind a thread that reaches from the point selected to the base of the foot. By many repetitions of this operation, carried on patiently day after day (for not above four or five threads are produced in the twenty-four hours), and by attaching the disc-like extremities of the threads to different places, the mussel at last completes its mooring and secures a safe anchorage.

The machinery whereby the byssus is manufactured, or *spun*, as some people erroneously term it, is very simple. Along the centre of the foot, which is at once distinguishable by its powers of elongation and contraction, and, in the edible mussel, by its deep violet colour, there is an open furrow, capable of being converted, at the will of the animal, into a closed canal, along which the glutinous secretion, whereof the threads are formed, flows. This is furnished by a glandular structure, situated near the base of the foot. The glutinous material is thus moulded into the shape of a thread, and speedily hardens into a strong, tenacious filament; so that, in accordance with the number produced will of course be the strength of the attachment.

The Pecten is likewise capable of manufacturing

threads of byssus, very closely resembling those of the mussel, only much shorter, and of a coarser texture, whereby the creature fixes itself to any substance that may be in its neighbourhood, whether it be a stone, a piece of coral, or any other solid object; and after storms they are not unfrequently found cast up among the rocks, where there were none the day before, and yet fixed by their threads as securely as if they had occupied the situation for months. Their byssus is produced exactly in the same manner as that of the mussel; only the organ with which they manufacture it is not so long, and has a wider groove, on which account the threads are necessarily thicker and shorter.

According to Dioscorides, whose dictum for many centuries received implicit assent among the disciples of learned antiquity, "the Escallop is engendered of the dew and air," as indeed was supposed to be the case with bivalves generally. Fortunately, in these days they seem to have changed their manners in this respect, and the aquariist may now observe them produced from eggs, which, owing to their brilliant orange colour, are very conspicuously visible. These eggs, when first laid, are received into one or other of the pairs of branchial laminæ, which become much swollen by their presence. It is in this situation that they are hatched, and give birth to a progeny totally dissimilar from their parents, although already enclosed in a pair of shells. They are indeed, on their first emergence from the egg, extremely active, and swim vigorously about in all directions by means of two prolongations derived from the mantle, which

are everted and covered with vibratile cilia, thus enabling the little creatures for a time to roam freely about in search of a locality adapted to their habits.

Nearly related to the Scallop is a very beautiful bivalve, the *Lima tenera*, remarkable not only on account of the elegance of its appearance, but from the circumstance that it builds for itself a nest, or rather bower, of which the Rev. David Landsborough gives an interesting description. The Lima differs from the Scallop in the circumstance that its fragile shell does not nearly cover the mollusk—the most delicate part of which, a beautiful orange fringe-work, is altogether external. "Had it no additional protection, the half-exposed animal would be a tempting mouthful, quite a *bonne bouche* to some prowling haddock or whiting; but 'He who tempers the wind to the shorn lamb,' teaches this little creature, which He has so elegantly formed, curious arts of self-preservation. It is not contented with hiding itself among the loose coral, for the first rude wave might lay it naked and bare: it becomes a marine mason, and builds a house, or nest: it chooses to dwell in a coral grotto; but, in constructing this grotto, it shows that it is not only a mason, but a rope-spinner, and a tapestry-weaver, and a plasterer. Were it only a mason, it would be no easy matter to cause the polymorphous coral to cohere. Cordage, then, is necessary to bind together the angular fragments, and this cordage it spins; but how it spins it, is one of the secrets of the deep. By some means or another, though it has no hand, it contrives to intertwine this yarn among the numerous bits of coral, so as firmly to bind

a handful of them together. Externally, this habitation is rough, and therefore better fitted to elude, or to ward off enemies; but though rough externally, within all is smooth and lubricous, for the fine yarn is woven into a lining of tapestry, and the interstices are filled up with fine slime, so that it is smooth as plaster-work, not unlike the patent 'Intonaco' of my excellent, ingenious friend, Mrs. Marshall. Not being intended, however, like her valuable composition, to keep out damp, or to bid defiance to fire, while the intertwining cordage keeps the coral walls together, the fine tapestry, mixed with smooth and moist plaster, hides all asperities, so that there is nothing to injure the delicate appendages of the enclosed animal."

When the Lima is taken out of its nest, and put into a jar of sea-water, it is one of the most graceful marine animals imaginable. The shell is beautiful; and the orange fringe-work outside of the shell is highly ornamental. Instead of being sluggish, it swims with great vigour, its mode of swimming being the same as that of the Scallop. It opens its valves, and, suddenly shutting them, expels the water, so that it is impelled onwards and upwards; and, when the impulse thus given is spent, it repeats the operation, and thus moves on by a succession of jumps. When moving through the water in this way, the reddish fringe-work is like the tail of a fiery comet. The filaments of the fringe are probably useful in catching prey. They are very easily broken off, and it is remarkable that they seem to live for many hours after they are detached from the body, swimming about like so many worms.

CHAPTER LII.

SOLEN SILIQUA—"THE RAZOR-SHELL."

. . . . . "Darest thou, Cassius, now
Leap in with me into this angry flood,
And swim to yonder point? Upon the word,
Accoutred as I was, I plunged in."

We need scarcely inform thee, gentle reader, that we regard ourselves as being ardently devoted to the study of Natural History, and gifted with a certain amount of enthusiasm in the prosecution of our favourite science; were it not so, we should not be now employed in penning these pages for thy instruction and amusement. It is not by any means our intention to underrate, in thy presence, our own prowess and self-devotion, and thus diminish our claims to be thy exemplar, as well as thy guide; but there are limits to human endurance, which it behoves the prudent naturalist to commiserate, and, however indomitable may be thy own ardour and perseverance, we plead for a moment the cause of thy weaker brethren, whose notions of naturalizing may not be quite commensurate with thine own.

We happened some years ago to enjoy the pleasure of a visit to the late Sir John Ross, the hero of the

North Pole, at that time but recently returned from his celebrated expedition. One evening, just before retiring to rest, we chanced, innocently enough, to express a wish to procure some Razor-shells—*muskins*, as they are there called, and were informed that the nearest point where they were obtainable was on some sand-banks in the vicinity of Glenluce; "however," said Sir John, "I will consult the almanac as to the state of the tides (the muskins being only obtainable at very low water), and shall be happy to drive you over." Of course, after expressing our obligations, we went to our chamber, and were soon soundly asleep, in blissful ignorance of the fate we had so inadvertently brought upon ourselves. Our slumbers did not last long; about half-past two in the morning we were hailed by the stentorian voice of Sir John at our bed-side, informing us that he found it would be low-water in the bay of Luce at half-past five o'clock —that he had ordered the pony-chaise to be at the door at three, and that there was only half an hour at our disposal to dress and get some breakfast.

I cannot say that the morning was particularly inviting for a ride, or that I looked upon the prospect before us with very pleasurable emotions. The month of November is at the best but ill-adapted to a naturalizing excursion; and, on the present occasion, not only was it intensely dark, but a Scotch mist hung around us like a London fog, through which the snow, as it came down in broad flakes, descended in silent profusion. However, as Sir John said *that* was of no consequence, off we drove, my teeth chattering with cold, as if in a fit of the ague; but it was

of no use uttering any complaint in presence of such a weather-proof companion, fresh as an iceberg from the polar seas.

After a *rather* chilly drive, we arrived at length upon the shores of the bay of Luce, and at once proceeded to knock up the fishermen who were to be our guides; after some difficulty, this was accomplished, and we then set off in search of the sea-side, the scene, as I thought, of our operations. The air was now beginning to grow clearer, and the mist had become less dense, so that objects were faintly distinguishable; at least, the white line of surf proclaimed that we were on the sea-beach, and we were preparing,

"So soon as heaven's window show'd a light,"

to set to work.

"There are no muskins here, my good fellow," exclaimed the thrice-hardy veteran; "they are over yonder." "Where?" I inquired. "Why, there," said Captain Ross, pointing right out to sea—"on a sand-bank half a mile out—you will see it just now, when it gets a little lighter."

"O! I suppose, then, we are waiting for a boat?"

"Boat! my dear fellow; here are no boats—WE MUST WADE IT! It won't reach up to your arm-pits: take that gun upon your shoulder; it will help to steady you."

"But, Sir John, I shall be catching my death of cold," I expostulated.

"Cold!—nonsense; no one ever caught cold in salt water yet. Here, come along! take hold of me—mind you don't stumble."

It was quite obvious there was no retreating; so, with desperate determination, in we went—Sir John in front, and a fisherman on each side of me—deeper and deeper still—until fairly up to our necks; and, holding the guns at arm's length above water, we at last crossed the strait, and gained the sand-bank on the other side, where, dripping with wet, and half-frozen, I mentally resolved never to associate myself in future with men who, like my Arctic friend, seemed to consider a bath at the temperature of 32° Fahrenheit quite warm and comfortable.

In order to understand our subsequent proceedings, it will be necessary briefly to narrate the habits of the Razor-shells, the objects of our expedition.

Unlike the Scallops, described in the last chapter, these creatures burrow in the sand to the depth of a foot and a half or two feet, and are in general only to be found near the low-water mark of spring tides, or upon sand-banks occasionally uncovered during the lowest ebb, the place of their retreat being usually indicated by perforations shaped like keyholes, corresponding to the form of the extremities of the siphons or tubes through which they respire. The position of the shell is always nearly vertical, and the animals, unless when disturbed, are usually found occupying a position within a few inches of the surface. The manner of catching them is as follows:—The fisherman, armed with a slender iron rod, furnished with a barbed head resembling a harpoon, treads carefully backwards over the beach, left bare by the retreating tide, and finds the holes in which the Solen lodges, by watching the little jet of water thrown out by the

animal, when, being alarmed by the shaking of the sand, it contracts its body*. Guided by the orifice through which the water is thus ejected, he plunges his rod into the sand, and generally succeeds in piercing the mollusk with its barbed point, and dragging it from its concealment; but, should he fail in his first attempt, he well knows that to try again would be unavailing, for the creature instantly works its way down to such a depth as to render pursuit hopeless.

A still simpler mode of obtaining them, without injuring the animal, is by putting a little salt upon their holes. The salt, penetrating the perforation in the sand, reaches and irritates the extremities of the siphons, when the mollusk, annoyed by the application, immediately mounts to the surface; by watching the moment, the vigilant aquariist may then seize the opportunity—and the Solen, if he can catch it; but, unless very quick in his movements, those of the "Razor" will be the quickest, and, once aware of the danger, the sensible shell-fish will not rise again, but submits patiently to the indignity of being salted alive rather than run the risk of being caught and roasted, or else cut up for bait.

Nothing is more wonderfully illustrative of the perfection of structure conferred upon these humble creatures, than the machinery whereby they are enabled to burrow beneath the compact, and, at the same time, loose material, wherein they dwell, a feat

* The Solen, or "Razor-sheath," derives its scientific name from the Greek word σωλήν, a pipe, or squirt; a term by no means inappropriate either to its shape or habits.

that may be readily witnessed; for, if the Solen be taken out of its hole and placed upon the sand, it immediately prepares to rebury itself, by the assistance of its enormous "foot," which it at once stretches forth to its full length. The extremity of the foot when thus protruded assumes a flattened form, tapering to a sharp point, and it is by means of this dagger-shaped instrument that the animal proceeds to perforate the sand. Driving the extremity of this singular weapon to a considerable depth, with the greatest facility, and then bending the end into the shape of a hook, it acquires a sufficient purchase to enable it to drag its shell into a vertical position, and this being accomplished, all that remains to be done is to bury itself still more deeply; for this purpose the foot is once more elongated and forced perpendicularly downwards to the extent of half, or two-thirds of the length of the shell, and, as the organ retains its dagger-shape while this is effected, it encounters but little resistance. Now commences the most remarkable part of the operation: the foot all on a sudden completely changes its shape; without at all diminishing in length, instead of being flat, it becomes at once round, or cylindrical, and then suddenly swells out near its extremity into a great fleshy globe, thus assuming a contour resembling that of the clapper of a bell. By means of the fleshy globe thus imbedded firmly in the sand, a secure hold is obtained; when, by shortening that portion of the foot which is situated between the globular dilatation and the shell, the latter is forcibly dragged downwards: and thus, by a repetition of the same

process, the creature manages to bury itself with a rapidity that is quite astonishing.

The manner in which it reascends towards the surface is precisely the reverse of the preceding operation: the foot becomes dilated into a bulb, close beneath the inferior end of the shell, and there, taking a firm hold of the surrounding sand, the Solen is enabled, by forcibly elongating the organ, to push itself upwards.

These movements of the foot may be readily witnessed when the Razor-shell has been dug up from its hiding-place, particularly that whereby it is enabled to bury itself in the sand; for, if held up in the fingers, it thrusts out its leg, and performs all the necessary evolutions, whilst making fruitless attempts to save itself after its usual plan of escape.

Other species of bivalves, when inclined for a walk, leisurely protrude this remarkable locomotive organ, and, extending it to the utmost, apply it cautiously to some solid support, and then, by contracting it, as with a painful effort, pull themselves along; the foot is now again extended in the same cautious manner, and the shell again dragged forward to the point of fixture. Reaumur has happily compared this mode of progression to that of a man, who, having laid himself flat on the ground, attempts to move onward by the sole aid of one arm; he stretches the arm out, to take hold of some object which he can just reach, and thus drags himself along: the difference between the action of the foot of the bivalve, and that of the arm, consisting only in the circumstance that, in the former, the shortening is effected by a general con-

traction of the whole organ; and in the latter, by muscles bending a joint. In a few rare instances the movement is retrograde: the animal plants the point of its foot against the clay or mud in the immediate vicinity of the opening of its shell, and then, by elongating the organ, pushes itself backwards; in the same way that a sailor shoves off a boat, by leaning against the oar which he has planted in the sand.

When the bend in the foot is considerable, forming a sort of elbow, as is the case in the Cockle for example, the creature is projected forward by a succession of short leaps; it stretches out the leg as far as possible, and by a sudden movement, similar to that of a spring let loose, is enabled to skip about with vivacity. In fine, so varied and multifarious are the performances of this versatile instrument, that, although a slight shiver creeps over us at the recollection, we still look back with pleasurable reminiscences at our visit to the Bay of Luce in company with the gallant discoverer of the North Magnetic Pole, on which occasion we for the first time had an opportunity of studying them to advantage.

CHAPTER LIII.

PHOLAS DACTYLUS.

"His bowre is at the bottom of the maine,
Within a mighty rock, 'gainst which doe rave
The roaring billows in their proud disdaine:
Chafed with the angry working of the wave,
Therein is eaten out a hollow cave,
That seems as mason's work with engine keen,
Had long while labour'd it to engrave:—
There was his wonne."

WHOEVER takes the slightest interest in the geological history of this planet, must have been impressed with the conviction, derived from unmistakeable evidence, that important changes are continually in progress between the relative situations of ocean and of the dry land; that the most ancient continents have been at one time or another submerged beneath the waves; and that what is now *terra firma*, by slow, and almost imperceptible submission to its mighty conqueror the sea, is on many parts of our coast yielding ground, inch by inch, before the incessant attacks of so unrelenting an antagonist. The proud and tempest-beaten cliff that beetles o'er the surge, slowly undermined by unseen and unsuspected agency, at length comes toppling down, encumbering the shore with

its vast ruins, apparently still imperishable, but which melt away in time, as though they were but fragments of an iceberg.

Rare, and sometimes welcome to the sight of the poor sailor, weary and tempest-tost, is the casual appearance of a drifting tree, which tells him generally that land is somewhere near; and yet, when we reflect what endless stores of floating timber every year roll down from the wild forest regions of both hemispheres, it becomes an interesting question how the wide ocean is kept clear from the accumulation of such obstructions.

Various are the agents silently at work, whose energies are specially devoted to this important service. The Pholades and Saxicavæ mine the solid rock as efficiently as the sappers employed at Sebastopol; while floating timber, vanishing more speedily, proclaims how easily, and yet how well, the "gimlet-mouth'd Teredo" does its duty. The truth is, that a whole army of miners is organized for the above purpose, which, under the general name of *Pholas*, have, from a very remote period, excited the attention of the natural historian, and even at the present day are very puzzling subjects for contemplation.

The word *Pholas* is derived from the Greek φωλέω, and signifies simply anything that is hidden; the name having been given to this genus of shell-fish from their custom of making for themselves holes in mud, clay, or other substances, and living in them hidden from observation; habits which, as may readily be supposed, necessitate important modifica-

tions in the structure of the animal. Throughout the various races of Oysters and Scallops, as we have already had an opportunity of remarking, the margins of the mantle being free and unattached, admission is at all times afforded to the surrounding water; and were creatures so circumstanced to be buried in sand or mud, they would speedily have their delicately-ciliated branchial fringes so completely clogged up that they would immediately perish.

In the boring bivalves, therefore, the mantle no longer offers the same simple arrangement; but the two sides becoming gradually more and more united along their edges, the bodies of these mollusks are by degrees entirely enclosed, as though shut up in a sac, so that the external element is denied admission, except by two membranous tubes, sometimes of considerable length, called *siphons*, through which the water is conveyed to the gills, and effete materials are expelled into the surrounding ocean.

We at once perceive the use of the tubular arrangement here referred to:—had the mantle been open, like that of the Scallop, respiration would have been impossible under the circumstances in which these creatures live; but, by the modification of structure thus provided, their tubes being prolonged to the mouth of the excavation wherein they reside, water is freely admitted to the branchiæ through one of the passages so formed, and again returned through the other in a vitiated condition. Whoever watches one of these siphoniferous bivalves in a living state, will readily appreciate the importance of this siphonal apparatus, especially if minute floating particles are

diffused through the water wherein the creatures are confined. It will then be seen that powerful currents are perpetually rushing through the extremities of each siphon, caused by the rapid action of cilia placed within; and that the streams thus produced not only form a provision for constantly changing the water in which the branchiæ are immersed, but forcibly convey floating molecules to the aperture of the mouth, which occupies a position very similar to that of the Scallop, described in a preceding page, and thus supplies abundance of nutritive materials, that could, in animals so destitute of prehensile organs, have been procured by no other contrivance. The whole arrangement, indeed, very closely resembles what we have already witnessed in the Ascidian races; only, instead of being merely agglutinated to foreign substances, the Pholades excavate for themselves a subterranean residence, wherein, living a life of comfortable indolence, they pass their time, and

> . . . . "in their pearly shells, at ease attend
> Moist nutriment."

The abodes of the *Pholas dactylus* are generally in black, sandy mud, and their colonies are readily discovered by treading heavily, or striking the beach with a stick, whereupon the alarmed inmates spirt water from their burrows; and on digging at the places thus indicated, the animals are easily exposed, each holding firmly to the interior of its den by means of its great *foot*, which cannot be withdrawn into the shell, and resembles a piece of translucent ice.

Placed in a vessel of sea-water, the smaller speci-

mens immediately protrude their siphons, and explore the surrounding bottom with them in a remarkably worm-like manner. The branchial currents commence instantly, and never cease unless the creatures are disturbed. The force and volume of these currents are quite marvellous to those who witness them for the first time. The inhalant orifice is trumpet-shaped, and guarded with cirrhi; the exhalant is a little contracted, and projects beyond the other.

The manner in which the stone-borers, "*Stein-bohrers,*" as the Germans call them, excavate their abodes, has long been a subject of interesting debate, and is even yet by no means satisfactorily settled. So completely was this part of their history unintelligible to the earlier naturalists, that Rondeletius was absolutely led to suppose, that the sea-water lodged in cavities in the rocks was itself converted into Pholades and other saxicavous mollusca!* and even the more philosophical Reaumur was driven to the belief that they entered the earth while it was yet in a soft state, which afterwards hardened by degrees around them. Various other explanations of this phenomenon have subsequently been at different times suggested, but scarcely with better success. Some have supposed that the creatures bore by the aid of a solvent liquor; others that their excavations are effected by file-like rasps, situated upon the exterior of the shell, and worked by its semi-rotatory movements, produced by appropriate muscles. Of late, various other theories

* "Ego crediderim in saxorum cavernulis, vel vi vel natura factis aquæ marinæ appulsu procreari, atque in concham verti, quæ cavitatis sive foraminis figuram servat."

have been propounded: the borings have been ascribed by an ingenious author to the action of currents of water directed against the parts to be worn away by the ceaseless play of ciliary action; these currents acting not so much by their force as by their constant and long-continued operation, just as the drops from the cave will in time wear a basin in the stone-floor underneath; while, according to Mr. Albany Hancock, the foot and mantle of these boring mollusks are crowded with siliceous particles, so as to represent rubbing-discs of extraordinary power, which act upon the rock like glass- or sand-paper, wearing it away by prolonged and continual attrition.

The opinions relative to the manner in which the Pholades excavate, however, may all be classed under five conclusions:—1st, that the boring Mollusca perforate by means of the rotation of the valves of their shells, which serve as augers; 2nd, that the holes are made by rasping, effected by siliceous particles studding the surface of certain parts of the animals; 3rd, that currents of water, set in action by the motions of vibratile cilia, are the agents; 4th, that the animal secretes a chemical solvent,—an acid which dissolves the substance into which it bores; 5th, that the combined action of a secreted solvent, and rasping, by the valves, effects the perforations. "Of all these theories," says Professor Forbes, "the chemical one, so far as a secreted solvent is concerned, bears least examination. The substances perforated are wood, limestones, hard and soft, argillaceous shales, clays, sandstone; and, in the case of a Pholas in the magnificent collection of Mr. Cuming,

wax; so that the notion of a menstruum that would act indifferently upon all these substances, is, at present at least, purely hypothetical.

Some of these bivalves are gifted with a phosphorescent faculty, and amongst these the Pholas holds a conspicuous place. Pliny says, "The phosphorescent fluid is so abundant in them, that it shines about the mouths of those who eat *Dactyli*, shines on their hands, and even on their clothes, from drops falling thereon;" and according to Reaumur, the Pholas secretes the fluid in sufficient abundance to answer this account. He removed the animal from the shell, and on placing it in the dark, the light appeared to emanate from every part of the surface, and on tearing it to pieces the internal parts seemed to be equally luminous :—

> "Take him, and cut him out in little stars,
> And he will make the face of heaven so fine,
> That all the world will be in love with night."

After having handled this Pholas, Reaumur, at first by accident and then on purpose, washed his fingers in a glass of water, which then appeared in the dark "as a vessel of milk would do in the full light of noon." The light thus emitted is of a bluish white colour, and is stronger in proportion as the animal is fresh and lively, more especially during the summer season.

What can be the use of this remarkable brilliancy to animals lying concealed in deep holes, which they have bored in clay or rocks, and for what purpose they illuminate their gloomy cells, it is difficult to

conjecture; unless, as Dr. Johnston suggests, it be to allure their prey, and perhaps to see

"by their own radiant light."

These Conchifera, like most others of our own coasts, are usually full of spawn in the spring or at the commencement of summer,—a period which, as relates to oysters, is kept sacred, as being the "close season." Previous to their expulsion, the young may be seen within a pellicle of jelly that encloses them, opening and shutting their tiny valves, and moving on their axes in a rotatory manner, as though practising their evolutions preparatory to their entrance upon active existence. We use the term advisedly, although perhaps some of our readers may smile at the notion of activity in their case; the fact, however, is as we state it; for no sooner do the young bivalves escape from their gelatinous cradles, than they begin to swim about in countless multitudes, rolling, tumbling, and darting to and fro, by means of ciliary paddles, with which they are at this time abundantly furnished, like so many insane steam-boats. Even the very oyster gambols and frisks in its new-born enjoyment of life; the mussels roam about at freedom; the stone-boring Pholas and other excavating tribes set off like schoolboys just released from school, in search of distant rocks, wherein to locate their numerous colonies; and all disperse themselves as instinct leads or chance directs, in search of fitting residence; some of them even swimming to considerable distances before they lose the locomotive faculty, and settle down for life.

The fertility of this class is prodigious. Leeuwenhoek reckoned that there were ten millions of embryo young produced by a single oyster. Baster reduces the number to a hundred thousand; and the reduction might be allowed, had not Poli added his authority for its more abundant fruitfulness. He is more precise: he says, "that an oyster may contain one million two hundred thousand eggs, and may give birth to the contents of twelve thousand barrels." Well might the reverend author of one of the 'Bridgewater Treatises' express his opinion, that "Providence has thus taken care that the demands made upon them to gratify the appetite of his creature man shall not annihilate the race." Such, indeed, is the fecundity of the Conchifera, that they would in the course of a short century fill our shallow lakes and rivers, and raise to the sea's surface the banks on its hollow bed, were it not for the numerous checks that oppose their undue multiplication, and retain in equipoise the balance between their prolific increase and the destruction that awaits them.

CHAPTER LIV.

GASTEROPOD MOLLUSCA.

"O, what an endlesse worke have I in hand,
To count the Sea's abundant progeny,
Whose fruitfull seede farre passeth those in land,
And also those which wonne in th' azure sky!
For much more eath to tell the starres on hy,
All be they endlesse seeme in estimation,
Then to recount the Sea's posterity;
So fertile be the floods in generation,
So huge their numbers, and so numberlesse their nation."

PARADOXICAL as the assertion may appear, it is undoubtedly consistent with general experience, that the beauties of Creation are by popular prejudice only deemed estimable in proportion to their rarity; or, in other words, that whatever is common or abundant, is on that very account contemptible and unworthy of notice. With a certain class of persons, the student of natural history, who, to their apprehension, does nothing but

"sigh for Nature's vermin,"

comes in for rather more than a due share of pity and charitable compassion. Poor fellow!

"He will pore by the hour
O'er a weed or a flower,
Or the Slugs that come crawling out after a shower.
Black-Beetles and Bumble-Bees—Blue-bottle Flies,
And Moths, are of no small account in his eyes;
An 'Industrious Flea' he 'd by no means despise;
While an old 'Daddy-long-legs,' whose long legs and thighs
Pass the common in shape, or in colour or size,
He is wont to consider an absolute prize."

Nay, sometimes the commiseration of our friends assumes a tone of still severer reproof, and with admirable thriftiness we are reminded that,—

"'Tis better learn to save one's clothes,
Than cherish Moths that eat them."

Eh bien!

"trahit sua quemque voluptas"—

Every one to his liking! and as unfortunately we have nothing but snails and slugs to talk about in the present chapter, we patiently submit our shoulders to the castigation of those who, despising such low pursuits, strive to rhyme us into better manners, and thus

"ballad us out o' tune."

Now, we must confess, that, in the perverseness of our imagination, we are in the habit of regarding these so-called "vermin" as very elegant and interesting objects; nay, we fearlessly uphold, that some of them are so conspicuously beautiful as to be amongst the most ornamental inmates of the aquarium, and doubtless, did space allow us, could enumerate a very lengthy list of examples confirmatory of this assertion;—the gorgeous *Sea-ear**, with its painted plumes

* Haliotis.

and iridescent shell; the top-shaped *Trochus*, circled round with hoops of crimson flame; the sculptured *Rissoa* and the stately *Murex*; *Scalaria* with its winding flight of stairs; and *Turritella*, like a moving spire of matchless tracery carried upon a living church; *Cypræa* clad in porcelain, and a hundred more, which almost every beach will furnish.

The "foot," which constitutes the distinguishing feature of these GASTEROPODS, is a very remarkable organ; its structure is entirely made up of an inextricable interlacement of muscular fibres interwoven in every possible direction. Progression is accomplished by a series of undulations, propagated in rapid succession along the *sole*, as we are tempted to call it; so that they appear to occupy the whole surface; resembling in miniature recurring wavelets on a tranquil sea, gently propelling the creature forward in a continuous manner, gliding, as it were, over any smooth plane. In progression, however, these animals are not restricted merely to crawl upon the rocks, or other solid substances; many of them can ascend to the top of the water, and use the surface as a liquid floor, along which they creep in the same manner as they do on land, with the difference only of having their body and shell in a reversed position, as though they were crawling across the ceiling of a room; many of our native species may be sometimes seen crossing pools upon the shore in this way, but how they manage to perform such a feat is by no means easily explicable. While floating in this manner, these living boats occasionally drop suddenly down, suspending themselves by a

delicate filament, which is fixed to their tail, or to the posterior extremity of the "foot." In this way they will let themselves gradually to the bottom, or remain for some time pendent in the water without apparent support, for the thread is so transparent that it is scarcely visible. When carefully looked for, however, it can always be perceived, originating in a track of mucus, forming a small inverted cone at the point from which the thread issues, and slightly dimpling the surface of the water; if alarmed, the animal falls at once to the bottom. This is effected by the foot quitting its hold on the suspending filament, when the mollusk, being specifically heavier than the surrounding element, immediately sinks.

In deep pools, at very low tides, the explorer of the beach will sometimes meet with an interesting Gasteropod of very striking appearance, named the APLYSIA (Pl. VIII. fig. 10), and which, we are happy to say, it is no longer felony to pick up. In former times, to search after the "*Sea-hare*"—such is its English name—was to render oneself suspected; and when Apuleius was accused of magic, because forsooth he had married a rich widow, the principal proof against him was that he had hired fishermen to procure him this animal. It were indeed long to tell

> .... "what drugs, what charms,
> What conjuration, and what mighty magic,"

these villanous sea-slugs are stated to have furnished, either to brew the deadly-venomed bowl, or "poison a young maid's affections;" for widely operative was their malignant influence.

"Few mollusks," writes Professor Forbes, "have

had greater popular fame, or a worse character, than the Aplysiæ. From very ancient times they have been regarded with horror and suspicion; and many writers on natural history, conversant with them only through the silly stories of ignorant fishermen, have combined to hold them up as objects of detestation. To touch them, according to European prejudices, was sufficient to generate disease in the fool-hardy experimenter; whilst Asiatics, reversing the consequences, maintained, perhaps with greater truth, that they met with instantaneous death when handled by man. Physicians wrote treatises on the effects of their poison, and discussed the remedies best adapted to neutralize it. Conspirators brewed nauseous beverages from their slimy bodies, and administered the potion, confident in its deadly powers. Every nation in the world on whose shores the poor Sea-hares crawled, accorded to them attributes of ferocity and malignant virulence; and yet, strange to say, there never appears to have been the slightest foundation for a belief in their crimes.

"The *Aplysia* is a perfectly harmless, gentle, timid, and, if observed in its native element, beautiful animal. Its odour, it is true, is sometimes not over-pleasant, and, when irritated, it ejects a fluid, the vivid purple hue of which may have excited alarm. Its shape, wherein it resembles, more than most mollusks, the body of some little quadruped, naturally attracted the attention of the curious; but why it should have excited their fears, and filled with terror the muscular hearts of sturdy fishermen, is a problem to be solved only when the predisposing causes of groundless super-

stitions shall have been thoroughly sifted and explained*."

The *Aplysiæ* live among sea-weeds in the Laminarian zone, rarely straying out of that region. Their food consists both of animal and vegetable substances, although they are often stated to be exclusively

* There is no doubt that, as far as relates to the Aplysiæ of our own shores, the above vindication of the character of these mollusks is well merited by their gentle and innocuous habits; and yet it is difficult altogether to discredit the evidence afforded, not only by ancient, but by modern writers, relative to the pernicious qualities of some foreign species. Bohadsch states that the fishermen in the Bay of Naples excused themselves for not procuring specimens, by saying that the animal was a filthy thing, which stank abominably. When removed from the sea, and placed in a vessel, according to this writer, there exuded a large quantity of a limpid, somewhat mucilaginous fluid, exhaling a sweetish, sickening, peculiar smell; but besides this, and distinct from its purple secretion, the Aplysia secretes also a milky liquor, formed in an internal conglomerate gland. As often as Bohadsch took the Aplysia from the vase of sea-water, and placed it upon a plate with the view of more narrowly examining its structure, the apartment was filled with a most fœtid, nauseous odour, compelling his wife and brother to leave the room. He himself could scarcely endure it, and had frequently to go out and breathe the fresh air. His hands and cheeks swelled after handling the creature for any length of time; but he is uncertain whether the swelling of the face proceeded from the *halitus* merely, or from having touched it with his hand besmeared with the liquid: probably the latter was the real cause, for when he purposely applied some of it to his chin, the hair came off from the part.—Bohadsch, *De Anim. Mar.*

An Aplysia, which Mr. Darwin met with at St. Jago, exudes an acrid secretion, which "causes a sharp, pungent sensation, similar to that produced by the Physalia, or Portuguese man-of-war."

vegetable feeders. They breed in spring, at which season they often congregate in vast numbers, laying their eggs among the Fuci imbedded in long and slender gelatinous ribands.

Beautiful as are the homesteads of many of the shell-bearing Gasteropods, and harmless as their occupants appear to the uninitiated, many of them, as the aquariist will often find to his cost, are not only eminently carnivorous and destructive, but are provided with most formidable instruments wherewith to satisfy their appetites; nay, strange to say, it is amongst themselves they wage an internecine war, as though they were resolved on mutual extermination. And yet, perhaps, it would be difficult to point out a race of animals apparently more secure from attack than the inhabitants of such stone-built citadels; so impenetrable are their shells, and so completely closed by the stone door that guards the entrance, we might think no robber's cave we read of in Arabian tales was ever more secure; and yet, by means as simple as they are admirable, the weakest and apparently most despicable assailant succeeds in its attack,

> ..... "and with a little pin
> Bores through their castle walls."

We will select as an example of these carnivorous tribes, the *Purpura lapillus* (Pl. VIII. fig. 12), a species to be met with abundantly on rocks or stones, in the space between tide-marks, where it is the doubtless unwelcome companion of periwinkles, limpets, and top-shells, all of which, if they had a vote in the matter, would probably prefer its absence; for it is

exceedingly voracious, and, when it gets hold of a neighbouring mollusk, seldom leaves it without eating it up. We have seen a Purpura devour a Periwinkle in the course of an afternoon, when placed in the same vessel of sea-water, a feat which it readily accomplishes; first, by means of its proboscis, drilling a hole through the shell of its victim, and then quietly and leisurely proceeding to eat the poor animal out of house and home.

The proboscis, by the instrumentality of which this is performed, is contrived with marvellous artifice: it is not simply provided, like that of the elephant, with the means of flexure and extension, but it can be entirely retracted into the body, by drawing itself into itself in such a manner, that that half of it which forms its base, contains and encloses the half nearest the point; and it can again be protruded from its sheath thus formed, by unfolding like the finger of a glove, or like the horns of the garden-snail.

The boring apparatus is situated at the extremity of this strange organ, and is a formidable instrument, armed with hooked and very sharp spines. It is supported by two long cartilaginous levers, the extremities of which form a pair of lips that can be separated or approximated, or made to move upon each other by the mass of muscles wherein they are imbedded, in such a manner that the spines covering them are alternately depressed and elevated; so that, by a repetition of these movements, the hardest shells are soon perforated, as by the action of a file.

No drill could do its work more cleanly, or more efficiently; and admission being once obtained by this

remarkable contrivance into the interior of the residence of its victim, we need hardly say that the clever house-breaker proceeds at once to help himself to the contents of the larder.

The eggs of these carnivorous Gasteropods are exceedingly interesting objects, and, from the facility with which they may be procured and nursed in the aquarium, can easily be made to afford an inexhaustible source of delightful amusement to any one who, with a little patience and a microscope, chooses to compare their varied forms, or examine for himself the wonderful mysteries, but half concealed by their transparent shells, connected with the evolution and development of the enclosed young.

The egg-cases of the common Whelk (*Buccinum undatum*) are to be picked up on every beach; they consist of numerous parchment-like capsules, of a compressed globular shape, united together into roundish masses, which in size and general appearance very closely resemble the nests of some humble-bees, and are known upon the coast by the familiar name of "wash-balls." Each of these capsules (*oothecæ*) contains three or four eggs, wherein, when approaching maturity, the young are distinctly discernible, already provided with little shells, consisting of about four whorls, and exhibiting to some extent the character of the adult. The "concamerated nidus" of the *Fusus antiquus* is still more curiously constructed: it forms an obtuse cone about three inches in height and two in diameter, made up of a number of pouches, in shape somewhat resembling the human nail, convex outwardly and concave on the inner side, encased

in a strong horny outer coat, but slit along the upper edge, so as readily to allow the exit of the little whelklings when mature.

Nassa reticulata, another form of Whelk, deposits its egg-capsules on weeds or stones fastened together, and overlying each other like the brass scales on the cheek-band of a soldier's helmet, each capsule having a shape like that of the spade on playing-cards. They consist individually of compressed pouches, nearly of the size of a silver penny, supported on very short pedicles, and opening at the top to give a doorway to the embryo when sufficiently advanced in growth.

The *oothecæ* of *Natica* are extremely curious, and were formerly described as a zoophyte, under the name of *Flustra arenosa*. The parent mollusk in this case either leaves its egg-clusters loose in sandy places, or attaches them so carelessly, that they frequently become loose; and the object of the remarkable form of the gristle-like mass under which they present themselves would seem to be to fit it for lying on sand without becoming deeply imbedded in it.

The shape of this substance is remarkable; it greatly resembles the hoof of a colt, and is about equal in thickness to the peel of an orange. It is composed of fine particles of sand, cemented by an animal gluten, very friable when dry, in which condition it bears a striking resemblance to a piece of Scotch oatcake. If held to the light it appears full of cells, arranged nearly in quincunx order, that, in fact, are so many capsules wherein the ova are contained; and these, if kept in the aquarium until they are hatched,

give birth to the young of a pretty Natica (*Natica monilifera*, Lam.).

The eggs of the *Purpura* are enclosed in little urn-shaped vesicles, of a membranous texture and yellowish colour, often tinged with pink, and may be met with standing erect, attached to the surface of rocks or stones, or sometimes on the parent shells themselves. Each of these little urns will be found, on close examination, to contain many young ones, which when mature escape from their confinement. Mr. Peach observed, that "so long a time as four months sometimes elapsed before the vesicle opened; and then the included whelklings did not quit their cradle all at once, but took their time in coming out, according to their individual dispositions; doubtless the quick-minded and more curious commencing

☞ The eggs of the Cephalopods or Cuttle-fishes are likewise interesting objects of study, although the animals themselves, from their rapacious habits, and the black secretion with which they occasionally convert the water around them into ink, are scarcely admissible into a well-regulated aquarium.

These eggs are always clustered together, and the pattern of the cluster varies in the different families. In the Sepia it resembles very exactly, both in size and colour, a bunch of black grapes (Pl. VIII. fig. 16). In the Octopus they are irregularly heaped in bundles, attached to Algæ; and in the Loligo or Calamary they are imbedded in a regular series of cells, in a long gelatinous intestiniform mass, from eight to twelve inches in length, many of them being united together by ligaments derived from a common centre; so that the cluster, when mature and entire, might be compared to a woollen mop: indeed the eggs are so numerous, that Bohadsch calculated a cluster of the average size to give birth to not fewer than 39,760 young squids!

their travels first, while those of slow and studious constitutions would remain as long as a fortnight before resolving to see the world for themselves."

The beautiful and very problematical race of CHITONS (Pl. VIII. fig. 13), which may be met with on every coast, attached to rocks, stones, or shells, have peculiar claims upon the attention of the aquariist, inasmuch as they are at present perfect zoologica puzzles, and even the class of animals to which they belong is a disputed point. Unlike any other mollusks, their bodies are protected by a series of shelly plates, resembling the scaly armour of the warrior (χιτὼν, a coat of mail), and were classed by the old conchologists as "multivalves." Some writers register them with the Annelidans, and perhaps there may be some points of resemblance; but, as our knowledge stands at present, we prefer to regard them as Gasteropods, which, with the exception of their shells, they closely resemble. The observant aquariist, who, while resident upon the coast, by obtaining their eggs, shall succeed in ascertaining the form they assume in their embryo condition, will make an important discovery and confer a boon upon science.

The Nudibranchiate Gasteropods, as they are called, distinguishable by their shell-less bodies, elegantly decked with branchial tufts or plumes, sometimes most gaily ornamented, next demand a passing notice. *Doris*, with gills resembling an expanded flower, displayed upon the hinder region of the back; and *Eolis*, adorned with painted ornaments, most gracefully disposed, bedight with tints so brilliant and harmo-

nious, that it might almost be taken for a bed of flowers endowed with life, and wandering about to show its splendours. These and a hundred more, presenting various forms of beauty, are procurable on every beach. Specimens of different species of *Doris* (Pl. VIII. fig. 15) are common on most parts of the coast, and sometimes are met with in considerable numbers. Thirteen occurred at once between the valves of an old empty shell, and at another time fifteen were obtained from a moderate quantity of miscellaneous gatherings; so that the reader need be under no apprehension of being disappointed in his attempts to obtain specimens for examination.

The spawn of these animals is deposited in the form of a long gelatinous riband, which is sometimes an inch broad and above a line in thickness, the dimensions of course depending upon the size of the parent. A *Doris* of medium bulk has been seen to produce in the course of ten days a spiral festoon, resembling a frill of fine lace, that must have contained at least 20,000 ova; and in larger specimens the number of the eggs really exceeds computation, insomuch that it almost baffles conjecture to account for the fate of a vast proportion of the multitudinous progeny of these prolific animals.

On cutting off a portion of the gelatinous frill in which the ova are enclosed, and subjecting them to examination with the microscope, a singular scene manifests itself. The most mature parts will be found to consist of numerous perfectly transparent capsules, of a spherical shape, deposited in the same mass of albuminous matter. In each of these cap-

sules are included two, three, or sometimes four embryos, all moving about with the greatest activity, and tumbling over each other apparently in high glee and enjoyment.

We will, however, select an example for special description :—

The spawn of the *Doris tuberculata* is a broad gelatinous riband, attached by one of its edges to the under side of stones in a circular coil of about three volutions, the whole forming a beautiful cup- or flower-like expansion. The number of ova imbedded in it cannot be less than 50,000. Each egg contains a single yelk; but frequently there are two, and sometimes even three yelks in the same egg. The period necessary for their attaining perfection is generally about a fortnight, after which time the mass presents a very animated spectacle. When examined with a common magnifier, the full-formed embryo may be seen in some, whirling itself round with great velocity in the transparent egg; others, having broken the shell, will be found performing more extended gyrations in the general envelope; while others, again, are swimming hither and thither in search of an aperture through which to escape into the open water.

The nascent animal forms a beautiful object for the microscope. Its body is enclosed in a very delicate, calcareous, nautiloid shell, furnished with an equally diaphanous operculum; and the whole surface of the little creature is covered over with minute vibratile cilia, as are also the internal walls of the alimentary canal, which is visible through the transparent covering. Two broad wing-like flaps form a very effi-

cient locomotive apparatus; these are fringed with long cilia, by the motion of which the minute being swims freely through the water: they are capable of being withdrawn into the shell and the operculum closed upon them. The mouth is situated between these lobes.

From the above description it will be at once seen that these little "*Nautilines*" do not bear even the most remote resemblance to the future *Doris*; and how long they remain in this state, or how their transformation takes place, is a very interesting subject of inquiry. In the second stage of growth, the diminutive Nudibranch is still found enclosed in its shell; but the mantle has become detached, and covers tightly the mass of the viscera. The foot is so enlarged, that it forms a considerable projection beyond the margin of its operculum—eyes and tentacles become conspicuous, and the tiny voyager swims with surprising quickness.

In the third stage the shell has fallen off, and the general shape is that of the parent, but the ciliated locomotive lobes still remain. In the fourth stage the creature begins to crawl in the Gasteropod fashion, until at length the full evolution of its organs completes the metamorphosis, and entitles the animal to the privileges of maturity.

Few, however, of such a multitudinous host are permitted to arrive at this stage of their existence. The young "*Nautilines*" have myriads of enemies in the shape of small infusoria, which may be noticed with a powerful microscope hovering round them, and ready to devour them the instant weakness or injury pre-

vents their keeping in action the cilia, which serve for defence as well as for locomotion. Let them cease to move, a regular attack is made, and the animal is soon devoured. It is curious to observe several of these little marauders sporting in the empty shell, as if in derision at the havoc they have made. The Nautilines themselves are mere specks; what must be the size of the conquerors? Thousands of young Nudibranchs perish thus early, in a few hours after coming into existence; indeed, if all came to maturity, our coasts would be literally covered with their multitudes.

We have already alluded to the beautiful adornments of *Eolis* (Pl. VIII. fig. 14), many species of which are of surpassing elegance. Neither are these creatures by any means such sluggards as many of their congeners, but on the contrary exhibit much violent action, and assume many strange attitudes. While reposing, supine, just under the surface of the water, the tentacula are generally recurved, like ram's horns, and the coloured branchial papillæ quietly crossed on the back. Should they, however, be in any way actively employed, were it even in simply taking a glide along the side of the tank, and any interruption or annoyance is suffered, the branchiæ bristle up in resentment or defiance. During contention for prey, all are in violent agitation, and the vehemence with which both they and the tentacula seem to strike is surprising. The animals also bite each other, and, in short, are amongst the most irritable and contentious creatures that can be imagined. During such hostile encounters, the branchiæ

are very liable to become torn off, and are then found to be long, round, pointed organs, extremely tenacious of life, contracting, extending, and apparently endeavouring to search for something lost, during a considerable period after their detachment.

Whether it be in accordance with the necessities resulting from such a disposition, or that the race is peculiarly exposed to mutilation, the deficient organs thus rudely sacrificed are speedily restored. Soon after the capture of several specimens, one of them was found to have lost a tentaculum by the root, and another was mutilated in a similar manner; in both cases reparation was speedily effected, the missing organ being reconstructed in the course of a fortnight. Another specimen lost the whole right tentacle by the root, on the 25th of September, and on the 28th lost likewise one of its cornicula, evidently two very important organs. How this loss had been incurred was unknown; but the mutual animosity displayed between the creature and a companion in the same vessel, as evidenced by the bristling up of their branchiæ, and biting each other whenever they met, led to conjecture that it was by violence. In the course of a month both of the missing organs were nearly restored to their pristine condition.

Some species of *Eolis* feed on the *Tubularia indivisa* and on the *Tubularia polyceps*, infesting those zoophytes in numerous colonies.

Their spawn is produced as an irregular, ovoidal, albuminous mass, containing 300 or 400 eggs. It appears at various seasons, summer or winter, June or December; but the chief breeding-time is perhaps

in March or April. The same specimen will sometimes spawn repeatedly at intervals, producing bundles of ova resembling minute sausages, measuring three lines in length, or less, and commonly found attached to the stalks of Tubularia.

Under favourable circumstances, the eggs may be observed arranged singly, as if in long compartments, across the mass; and when nearly mature, if examined under the microscope, will be found to contain active beings, which, on escaping from their confinement, prove to be *Nautilines*, resembling the progeny of *Doris*, already described; these immediately begin to swim about with great vivacity, some individuals pursuing their course singly through the water; or several, clustering together, may be seen revolving horizontally in merry dance, and forming a most amusing and interesting scene. Nothing more, however, than what has already been recorded, relative to the general structure of Nautilines, distinguishes these diminutive larvæ.

The *Eolis* dwells in society, and is rarely found solitary. It is one of the few Nudibranchiates whose food is known, which renders it a favourite subject for observation; and as the young grow readily, and rather speedily, the progressive evolution of their different organs may be satisfactorily investigated. Still it must not be supposed that all the *Eolides* have appetites precisely similar. The "*Porcupine Eolis*" (*Eolis hystrix*), for example, shows several peculiar propensities. It does not shun the light; and, above everything, its voracity, so different from the usual habits of its race, is most remarkable. It feeds

greedily on mussel and on periwinkle, swallowing large portions entire, till it becomes evidently distended with the quantity; it will likewise eat black *Planariæ*; and, sad to say of so pretty a creature, seems quite ready to devour its own species.

CHAPTER LV.

FISHES :—AMPHIOXUS—ECHENEIS—SYNGNATHUS—CONCLUSION.

. . . . "And fish that with their fins and shining scales
Glide under the green wave; . . . . .
. . . . . part single, part with mate,
Graze the sea-weed their pasture, and through groves
Of coral stray, or sporting, with quick glance,
Show to the sun their waved coats dropp'd with gold."

To complete our already lengthy list of animals adapted to the aquarium, either on account of their beautiful structure, or the interest attaching to their history, we have yet to notice the Fishes, properly so called,—an important group, which at least, so far as regards the enlivenment of the tank, some of our readers may consider to be

. . . . "the master-work, the end
Of all yet done."

Varied, indeed, and never-failing subjects of admiration are many of the species to be met with on the coast, and were they equally harmless to their neighbours, the reader would have only to select the prettiest forms, suitable by their size or playfulness, to be the inmates of his collection; but, as has been

already observed in our opening chapter, the choice must be made with caution, for unfortunately the association of most of them with rare specimens belonging to the inferior ranks of life is at all times a very hazardous experiment; the innocence of their appearance and the gaiety of their apparel are frequently allowed to plead powerfully in their behalf, and we must therefore warn our friends against the indiscriminate voracity for which they are too often conspicuous—

"nimium ne crede colori."

There are, however, a few we wish to recommend to the notice of the aquariist, as being remarkable for peculiarities in their economy of sufficient importance to arrest attention.

The Lancelet (*Amphioxus lanceolatus*) (Pl. VIII. fig. 17) is perhaps one of the most paradoxical creatures met with in the whole range of Natural History —a fish without either head, brain, or eyes, and yet having a distinct vertebral column—possessing, instead of gills, the branchial apparatus of an Ascidian; and so entirely anomalous in its entire organization, which, owing to the transparency of the creature, may be distinctly studied under the microscope, that it may well be regarded as the greatest puzzle in the Animal Creation*, and a subject well worthy of the closest study.

The Sucking-fish (*Echeneis Remora*) (Pl. VIII.

* For a full account of the anatomy of this wonderful animal, the scientific reader is referred to the author's "General Outline of the Structure of the Animal Kingdom," 2nd edit.

fig. 18), although by no means common, is occasionally to be met with upon our coast, and is at once recognizable by the flattened oval adhesive disc, situated upon the top of its head, by means of which singular contrivance the creature is able to attach itself firmly to the surface of other fishes, or to the bottoms of ships; but whether for protection or convenience, is a question not yet satisfactorily ascertained. Long before the invention of railways, the little Remora was enabled to appreciate to the fullest extent the advantages to be derived from rapid travelling and cheap fares, indulging itself with both to its heart's content whenever inclined for an excursion; and, moreover, by no means restricted to some given line of road, inasmuch as, simply selecting any passing shark, or other fleet conveyance, without even the ceremony of taking a ticket, it is able to assume possession of its outside place, and whenever it chooses, by the mere detachment of its adhesive disc, it at once alights, without troubling itself at all about "the company's servants."

We can easily imagine the envy with which such privileges were regarded in ancient times, and are scarcely surprised that a poor little fish thus eminently favoured should soon become a mark for the shafts of detraction and slander; nay, that it should be accused of crimes and misdemeanors to which the sin of witchcraft was venial. That a witch could ride on a broomstick was mere child's play in comparison with the atrocious feats of the Echeneis, that is able, as we are told, to arrest the progress of a man-of-war in full sail (ἐχενηΐς, ἔχω—ναῦς, holding ships back),

and positively change the fate of empires by interfering with the exploits of kings and kaisers :—

"Looking far forth into the ocean wide,
A goodly ship, with banners bravely dight,
And flag in her top-gallant, I espy'd,
Through the main sea making her merry flight;
Faire blew the wind into her bosome right;
And th' heavens lookèd lovely all the while;
That she did seem to daunce, as in delight,
And at her own felicity did smile.
All suddainly there clove unto her keele
A little fish that men call REMORA,
Which stopp'd her course, and held her by the heele,
That winde nor tide could move her thence away.
'Tis straunge, me seemeth, that so small a thing
Should able be so great an one to wring."

Pliny descants upon this subject with his usual gravity, and the reader may possibly be amused with an old translation of the account given by the Roman naturalist :—

"The current of the sea is great, the tide much, the winds vehement and forcible; and more than that, ores and sailes withall, to help forward the rest, are mightie and powerfull; and yet there is one little sillie fish, named *Echeneis*, that checketh, scorneth, and arresteth them all. Let the winds blow as much as they will, rage the storms and tempests what they can, yet this little fish commandeth their furie, restraineth their puissance, and maugre all their force, as great as it is, compelleth ships to stand still, a thing which no cables, be they never so big, and able as they will, can perform. She bridleth the violence and tameth the greatest rage of this universall world,

and that without any paine that she putteth herself unto, without any holding or putting backe, or any other means, save only by cleaving and sticking fast to a vessel; in such a sort that this one small and poore fishe is sufficient to resist and withstand so great a power both of sea and navie; yea, and to stop the passage of a ship, doe what they will to the contrarie. What should our fleets and armadoes at sea make such turrets in their decks and forecastles for? Wherefore should they fortifie their ships in warlike manner, to fight from them upon the sea, as it were from mure and rampier on firme land? See the vanitie of man! Alas, how foolish are we to make all this adoe, when one little fish, not above half a foot long, is able to arrest and stay perforce, yea, and hold as prisoners, our goodly tall and proud ships, so well armed in the beakehead with yron pikes and brazen tines; so offensive and dangerous to bouge and pierce any enemies' ship which they doe encounter! Certes, reported it is, that in the naval battaile before Actium, wherein Antonius and Cleopatra the queene were defeated by Augustus, one of these fishes staid the admiral's ship, wherein M. Antonius was, at what time as he made all the hast and meanes he could devise, with help of ores, to encourage his people from ship to ship, and could not prevaile, untill he was forced to abandon the said admirall and go into another galley. Meanwhile the armada of Augustus Cæsar, seeing this disorder, charged with greater violence, and soone invested the fleete of Antonie.

"Of late daies also, and within our remembrance,

the like happened to the Roiall ship of the Emperor Caius Caligula, at what time as he rowed backe and made saile from Astina to Antium; when and where this little fish detained his ship. And yet it was not long ere the cause of this wonderfull staie of his ship was known; for so soon as ever the vessel (and a galliace it was, furnished with five banks of ores on a side) was perceived alone in the fleet to stand still, presentlie a number of tall fellows leapt out of their ships into the sea to search what the reason might be that it stirred not, and found one of these fishes sticking to the very helme; which, being reported to Caligula, he fumed and fared like a very emperour, taking great indignation that so small a thing as it should hold him back perforce, and check the strength of all his mariners, notwithstanding there were no fewer than four hundred lustie men in his galley, that laboured at the ore all that ever they could to the contrarie. But this prince (as it is for certaine knowne) was most astonied at this, namely that the fish, sticking only to the ship, should hold him fast, and the same being brought into the ship should not work the like effect."

Nay, even this is not the extent of delinquency attributed to the poor Remora, although it seems to have some useful qualities too:—

"It enters into the composition of poisons which extinguish all feelings of love: it impedes justice, and arrests the mandates of the tribunals *judiciorum mora*; but, in virtue of the same power, it can compensate for the evils thus produced. It preserves pregnant women from accident, and, if salted, its very ap-

proach is sufficient to draw gold out of the deepest wells into which it may have accidentally fallen!"

The SYNGNATHIDÆ, or "Pipe-fishes" (Pl. VIII. figs. 19 & 20), constitute a most interesting and curious group, remarkable from the circumstance that their jaws are united, forming a tube more or less cylindrical (*σὺν*, together; *γνάθος*, the jaw); they are likewise called LOPHOBRANCHII (*tufted branchiæ*), and are distinguished from all other fishes by having their gills, instead of being comb-shaped, as in other races, divided into little rounded tufts disposed in pairs along the branchial arches. The gills have likewise this further peculiarity, that, instead of being protected by a moveable gill-flap, as is generally the case, they are entirely enclosed beneath a large operculum attached all round by a membrane which only permits the water to escape through a small hole.

Mr. Lukis, who had two female specimens of the *Sea-horse* (*Syngnathus Hippocampus*) for some time in a glass vessel, describes their actions as being equally novel and amusing. "An appearance of searching for a resting-place induced me," says that gentleman, "to consult their wishes, by placing straws and sea-weed in the vessel. The desired effect was obtained, and gave me much to reflect upon in their habits. They now exhibit many of their peculiarities, and few objects of the deep have displayed *in prison* more sport or more intelligence."

When swimming about, they maintain a vertical position; but the tail is ready to grasp whatever it meets in the water, quickly entwines in any direction round the weeds, and, when fixed, the animal intently

watches the surrounding objects, and darts at its prey with great dexterity. When both approach each other, they often twist their tails together, and struggle to separate, or attach themselves to the weeds. This is done by the under part of their cheeks or chin, which is also used for raising the body when a new spot is wanted for the tail to entwine afresh. The eyes move independently of each other, as in the chameleon: this, with the brilliant, changeable iridescence about the head, and its blue bands, forcibly remind the observer of that animal.

From the great similarity in the form and size of the mouth in all the species of the *Syngnathi*, it is probable that their food is also similar. Worms, small mollusca, young and minute thin-skinned crustacea, and the ova of other fishes, are amongst the substances sucked up,—a feat which the Pipe-fishes apparently perform by dilating their throats, so as to draw food up their cylindrical beak-like mouth, as water is drawn up the pipe of a syringe.

The male differs from the female in being, from the vent to the tail-fin, much broader, and in having for about two-thirds of its length two soft flaps, which fold together, and form a bag or pouch, something resembling the nest-like pouch of the kangaroo and other marsupial mammalia. In this pouch of the *male* fish, strange to say, the ova of the female are deposited and matured; nay, even after they are hatched, they still find in this remarkable paternal pouch a refuge and safe retreat in time of danger. It is even stated by fishermen, that if the young are shaken out of the pouch into the water, over the side

of the boat, they do not swim away; but, if the parent-fish be restored to his native element, will again enter the well-known refuge, as there only being assured of safety and protection.

In other species of Pipe-fish, such as the *Syngnathus Ophidion*, neither male nor female possesses an abdominal pouch; but nevertheless the ova, after being deposited by the female, are carried about for a time by the male in separate hemispheric depressions on the external surface of the abdomen, until they are hatched.

And now we must conclude our pleasing task; but, ere we say farewell to the frail glass and mimic masonry,—the petty theatre in which we have endeavoured to display so many perishable wonders,—let us pause awhile, if but to take a parting glance at the amazing scene.

These humble forms of life, though each of them might well require a volume to elucidate its history, were, most of them, but a few years ago, almost unknown even to those whose study is to search out Nature's works. Let not the reader, then, suppose the mine exhausted, or that nothing now remains to lure attention or reward research; the wonder is, how little has been done; how few the labourers that have toiled in such an ample field; or, should we rather say, have left on record what they have observed?

It has often occurred to us, that one very important cause of this paucity of original observation is to be ascribed to a feeling of diffidence, natural enough in

the young naturalist, as to the novelty or importance of his labours,—a feeling for which, at present at least, there is, unfortunately, but very little real foundation. Science is not as yet by any means so rich in information, even as relates to the commonest productions of the ocean, as to render additions to our stock, however trifling, either misplaced or unwelcome; and we venture to say, that there are few subjects upon which the results of accurate observation would be unacceptable. Every established fact faithfully recorded is as a new light set upon a candlestick, and in the exact ratio of the number of such contributions will be the clearness with which science will be able to see its way through the obscurity which still surrounds many interesting phenomena.

But here we would remind the student, that there is a wide distinction to be drawn between facts and theories; nay, we may be permitted to say, between pure unsophisticated truth, and truth seen through the medium of a theoretical bias, which not unfrequently tints it with a false colour, or even distorts it altogether—much in the same way as a pretty face becomes hideous when seen through an irregularly refracting piece of glass. Alas, from this cause, how many an elaborate superstructure, based on some visionary foundation, have we seen spring into ephemeral existence only to be forgotten!—

> "How many a system, raised
> Like Neva's icy domes, awhile hath blazed
> With lights of fancy and with forms of pride,
> Then, melting, mingled with the Oblivious tide!"

We advise our young friends to have nothing to do

with speculative opinions, which, like *ignes fatui*, are continually misleading the ardent and enthusiastic aspirant into all sorts of quagmires and impassable swamps, but to content themselves with the reflection that it is man's place to be the student, not the critic of creation,—his simple duty and his highest privilege consisting in the endeavour to derive, from the contemplation of the Creator's attributes, a clearer knowledge of Himself, who is

> . . . . "to us invisible, yet dimly seen
> In these His lowest works:"

and that, in such a true spirit of humility and pious reverence as befits our ignorance and incapacity.

> "Teach my endeavours so Thy works to read,
> That, learning them in Thee I may proceed;
> Give Thou my reason that instructive flight,
> Whose weary wings may in Thy hands still light;
> Teach me to soar aloft, yet ever so,
> When near the sun to stoop again below.
> Thus shall my humble feathers safely hover,
> And though near earth, more than the heavens discover."

"I had rather," says Lord Bacon, "believe all the fables in the legend, and the 'Talmud' and the 'Alcoran,' than that this universal frame is without a mind; and, therefore, God never wrought miracle to convince atheism, because his ordinary works convince it. It is true that a little philosophy inclineth man's mind to atheism, but depth in philosophy bringeth men's minds about to religion: for while the mind of man looketh upon second causes scattered, it may sometimes rest in them, and go no further; but when it beholdeth the chain of them confederate

and linked together, it must needs fly to Providence and Deity."

If this be true of science generally, surely it must be emphatically as regards the animal creation,—so vast in its extent, exhibiting at every step such close relationships, and yet such infinite variety—such countless manifestations of supreme design and unspeakable wisdom, of limitless beneficence and omnipresent agency,—all pointing out, with finger unmistakeable, the power, the goodness, and the majesty of God.

"There, Science, veil thy daring eye,
Nor dive too deep, nor soar too high,
In that divine abyss:
To Faith content thy beams to lend,
Her hopes assure, her steps befriend,
And light her way to bliss."

THE END.

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